FIRST ELEMENTS
OF
ASTRONOMY
AND
Natural Philoſophy;

WHEREIN

The Knowledge of thoſe Sciences are rendered more ſimple, and the SOLAR SYSTEM *deſcribed in a familiar Manner:*

ALSO THE

POWERS OF ELECTRICITY, THUNDER, LIGHTENING, METEORS, WINDS, HEAT, COLD, *&c.*

WITH SUITABLE

REFLECTIONS

ON THE

WORKS OF PROVIDENCE.

FOURTH EDITION, CORRECTED.

For the Uſe of Private Families, and Public Schools.

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ADDRESS TO THE PUBLIC.

AT the particular deſire of ſeveral friends, the Editor of the ELEMENTS of ASTRONOMY, &c. has been induced to ſeparate from it the Geographical Part; by which means he has been enabled conſiderably to enlarge the former ſubjects, and which, from their preſent form, he hopes will be found to merit that liberal ſupport with which the work has hitherto been honoured. The Moral Reflections that are blended throughout the whole volume will, he doubts not, be highly acceptable to all Parents and Guardians.

STRAND, *June 20th*, 1798.

PREFACE.

ASTRONOMY is ſo pleaſing a ſtudy, that it can hardly fail of being agreeable to a young mind; it is capable of affording the moſt delightful impreſſions, and awakens the curioſity to ſubjects at once inſtructive and entertaining: it gives a lively idea of the *Deity*, and juſt notions of his Providence; for who can ſee the Sun riſe in its glory, without feeling a glow of gratitude towards the *Author* of ſo much good to man? Or who can contemplate the plant and flower nouriſhed by its influence, without wonder and admiration?

> All, all, where'er we look, is full of God!
>
> LUCAN.

Nor are theſe pleaſing reflections made without having their connexion with truth, religion, and morality; the mind ſo diſpoſed will be humane and benevolent, and, while it adores the Creator, will feel good-will to its fellow-creatures.

The pleaſures of the imagination are novelty, wonder, and beauty; that Aſtronomy poſſeſſes each of theſe requiſites no one will diſpute; it is then only neceſſary to diſrobe Science of her pedantry to make her pleaſing to youth, to lead the tender mind to ſtudy the nobleſt works of nature, and to excite

> The fond attentive gaze of young aſtoniſhment.
>
> AKENSIDE.

The object of this little volume is to amuſe as well as to inſtruct, and, while it gives conciſe and eaſy explanations, to make them acceptable, by ſelecting the moſt pleaſing and neceſſary ſubjects of Aſtronomy, interſperſed with moral precepts that may adorn the *heart* and improve the *underſtanding*.

A celebrated writer has given to one of his pages the following intereſting remarks on our globe:

" The natural advantages which ariſe from the poſition of the earth which we inhabit with reſpect to the other planets, afford much employment to mathematical ſpeculation, by which it has been diſcovered, that no other conformation of the ſyſtem could have given ſuch commodious diſtributions of light and heat, or imparted fertility and pleaſure to ſo great a part of a revolving ſphere.

" It may be, perhaps, obſerved by the moraliſt, with equal reaſon, that our globe ſeems particularly fitted for the reſidence of a being, placed here only for a ſhort time, whoſe taſk is to advance himſelf to a higher and happier ſtate of exiſtence, by unremitted vigilance of caution, and activity of virtue.

" To this end all the appearances of

nature uniformly conſpire. Whatever we ſee on every ſide reminds us of the lapſe of time and the flux of life. The day and night ſucceed each other; the rotation of ſeaſons diverſifies the year; the ſun riſes, attains the meridian, declines, and ſets; and the moon every night changes its appearance.

"The day has been conſidered as an image of the year, and the year as the repreſentation of life. The morning anſwers to the ſpring, and the ſpring to childhood and youth; the noon correſponds to the ſummer, and the ſummer to the ſtrength of manhood; the evening is an emblem of autumn, and autumn of declining life. The night, with its ſilence and darkneſs, ſhews the winter, in which all the powers of vegetation are benumbed; and the winter points out the time when life ſhall ceaſe, with its hopes and pleaſures."

JOHNSON.

The plan of this work is to avoid the abſtruſeneſs too commonly found in books intended for children, to diſplay the wonders of creation, to impreſs ſentiments of religion, and to aſſiſt the inquiries of genius; as ſuch it is offered to parents and others, with a ſincere hope that it may be found in ſome degree ſerviceable to youth.

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FIRST ELEMENTS

OF

ASTRONOMY.

With what an awful, world-revolving power
Were firſt th' unwieldy planets launch'd along
Th' illimitable void! thus to remain
Amid the flux of many thouſand years,
That oft has ſwept the toiling race of men,
And all their labour'd monuments away,
Firm, unremitting, matchleſs, in their courſe:
To the kind temper'd change of Night and Day,
And of the Seaſons ever ſtealing round,
Minutely faithful:—ſuch th' all-perfect Hand
That pois'd, impels, and rules the ſteady whole.

THOM. SEASONS.

LESSON I.

ON TIME.

IN moſt of the common affairs of life nothing is more neceſſary than an exact meaſure of *Time*; but how is this to be obtained? It is to the heavens alone that we muſt look for a certain and invariable ſtandard. Thoſe magnificent bodies that are placed at ſuch immenſe diſtances from our globe, move with an order and regularity which is not to be found in any other part of the creation. From them we have obtained all our knowledge of the Seaſons, and the art of reckoning by certain periods of time. Had their motions been as various and mutable as thoſe which we obſerve upon the earth, we ſhould have had no idea of the regular lapſe of time, or the extent of duration; which is ſtill the ſtate of uncivilized and ſolitary barbarians in many parts of the globe.

The interval between the riſing and ſetting of the Sun is a meaſure of time, which is called a day, and is what is pointed out to us by the Creator himſelf; but as we are frequently in want of a much longer period, we are obliged to have recourſe to other obſervations than thoſe which depend upon the appearance and diſappearance of the Sun: ſome nations compute their time by the revolutions of the *Moon*, or by *months*; ſome by the revolutions of the *Sun*, or by *years*; and others again by months and years. But this requires an exact knowledge of the celeſtial motions, and thoſe who make uſe of both the revolutions together ſhould know how to conciliate and make them agree. It was this that gave birth to the calendar of days and months, which was for a long time extremely imperfect, has been often reformed, and is ſtill in need of improvement.

In all civil computations a day is uſually divided into twenty-four hours, reckoning twelve from midnight to noon, and twelve from noon to midnight again; but an aſtronomical day is the interval between noon and noon, or the time elapſed between two ſucceſſive tranſits of the Sun's centre over the ſame meridian.

The knowledge which *Aſtronomy* affords us, of the true ſyſtem of the world, and the invariable laws by which it is governed, has opened to us ſuch a magnificent view of the creation, that we are ſtruck with aſtoniſhment at the grandeur of the ſpectacle, and the powers of an all-wiſe God. By looking abroad into the univerſe, we exalt our ideas of his ſupreme goodneſs, and extend the narrow ſphere of human conceptions. The faculties are ſtrengthened and improved, the underſtanding is enlarged, and the mind, in the contemplation of ſo many glorious objects, finds itſelf drawn to delight in that Being who informs, directs, and animates the whole.

* * *

LESSON II.

THE SOLAR SYSTEM.

In the beginning God created the Heaven and the Earth.

The Heavens declare the glory of God, and the Firmament ſhoweth his handy work.

THE Sun, with the Planets and Comets which move round him, conſtitute what is called the Solar Syſtem.

Nearly in the centre of this regular and beautiful ſyſtem is

THE

THE SUN.

The powerful king of day. THOMSON.
Which is a bridegroom coming out of his chamber, and rejoiceth as a ſtrong man to run a race.

The Sun is an immenſe globe of fire, the fountain of light, and principle of vegetation: to its influence we owe the changes of the ſeaſons, the healthfulneſs of Spring, the beauties of Summer, and the gifts of Autumn; nor is it further removed from us in Winter but to return again to reſtore the face of nature, and to bleſs us with plenteouſneſs. How admirably too has that Being who directs all things, tempered its beams to the ſtate of man, that in its mid-noon it ſhall not hurt him!

The Sun remains nearly ſtationary in the heavens, but turns upon its own axis in about 25½ days. There are ſeven planets moving round him, each in a different orbit. The orbit of a planet is the path it deſcribes in the heavens, which is nearly circular.

The names of the planets, according to the order of their diſtance from the Sun, are, *Mercury*, *Venus*, the *Earth*, *Mars*, *Jupiter*, *Saturn*, and the *Georgium Sidus*. The two firſt, Mercury and Venus, are called *inferior* planets, becauſe they move within the Earth's orbit; that is, nearer to the Sun. The four laſt are called *ſuperior* planets, becauſe their orbits are without that of the Earth.

The figure of the planets is that of a ſphere or globe; and ſome of them turn upon their own axes from weſt to eaſt; at the ſame time, by a progreſſive motion through their orbits from weſt to eaſt, they revolve round the Sun, which is ſtationary in the centre. They have no light of their own, but ſhine by means of the borrowed light which they receive from the Sun.

The axis of a planet is a line conceived to be drawn through its centre, on which it revolves or goes round. A bowl whirled from one's hand into the air turns round ſuch a line within itſelf, while it moves forward: ſuch are the lines we mean when we ſpeak of the axes of the heavenly bodies.

Thoſe places which lie under the ſame meridian have exactly the ſame hours of the day, becauſe, when the Sun comes to the meridian of any place, it is noon or mid-day there, and conſequently all other places under the ſame meridian muſt have their noon at one and the ſame inſtant of time.

At the approach of ſpring, there are revolutions before our eyes, which muſt fill every attentive obſerver with aſtoniſhment. Nature gradually recovers the life ſhe ſeemed to have loſt in winter. The earth is clothed with verdure. The trees are covered with bloſſoms. On all ſides are ſeen new generations of inſects, and other animals, coming out, rejoicing in their exiſtence, and endowed with a thouſand different inſtincts. Every thing is animated. Every thing revives. And this new life, which appears in the nobleſt parts of nature, is produced by the return of warmth, which awakens animals and plants, and puts their renewed ſtrength in motion. We owe this admirable revolution to the SUN, which is the ſource of life, ſenſation, and joy, as its ſalutary and enlivening rays are ſpread over all nature. The ſeeds feel its effect, and open in the boſom of the earth. It is from thence that the plants and vegetables ſhoot, ſpring up, and grow. Its approach revives and ſtrengthens the animals. Every living creature that has breath or living, vegetation alſo, feels the benign influence of that majeſtic globe. What a ſource of joy and gladneſs would the heart of man be deprived of, if he could not enjoy the rays of the riſing ſun, or the light of a ſerene day! —

LESSON III.

MERCURY

Is the neareſt planet to the Sun, and moves round him in rather leſs than three months, which is the length of his year; the year being the ſpace of time a planet takes in going round the Sun. Mercury is ſeldom ſeen, on account of his being ſo near to the Sun as to be moſtly concealed by his rays.

> ——His diſk
> Can ſcarce be caught by philoſophic eye,
> Loſt in the near effulgence. THOMSON.

The time of his rotation on his axis, or the length of his days and nights, is not yet known.

VENUS,

The next planet to Mercury, makes her yearly revolution round the Sun in about 7½ months; and her diurnal or daily rotation upon her own axis in about 23½ hours. When this planet appears to the weſt of the Sun, ſhe riſes before him in the morning, and is called the Morning Star, or, as Dryden beautifully expreſſes it,

> Guide of the ſtarry flock!

When ſhe appears to the eaſt of the Sun, ſhe ſhines in the evening after he ſets, and is then called the Evening Star; being in each ſituation, alternately, about 7½ months. She is nearly as large again as our Earth.

THE EARTH.

It was formerly thought that the Earth reſembled a long cylinder; by ſome it was imagined to be one flat extended plane. Suppoſing the primitive figure of the Earth to have been that of a globe or ſphere, the centrifugal force, or the action ariſing from a conſtant rotation upon its axis, would change it into an oblate ſpheroid. This was the figure determined by

Newton, who found, by mathematical calculations, that the polar diameter of the Earth is to the equatorial as 229 is to 230, or that the regions of the equator are elevated about 35 miles more than thoſe at the poles.

The annual revolution of this planet is performed in 365 days, 5 hours, and 49 minutes, or rather more than 12 months; and its diurnal rotation in about 24 hours. Every fourth year, one day is added at the end of February, to recover the time which the Earth ſpends in her annual courſe above the 365 days, which compoſe a common year. This fourth year, therefore, conſiſts of 366 days, and is called Biſſextile, and alſo Leap-year.

The Moon moves round our Earth as a ſecondary planet.

MARS.

This planet completes his revolution round the Sun in ſomewhat leſs than two of our years, and his rotation upon his axis is rather more than $24\frac{1}{2}$ hours. Mars is ſeven times ſmaller than our globe.

JUPITER.

This planet is flattened about his poles in nearly the ſame manner that has been aſſerted of our Earth; but as his rotation upon his axis is performed with greater rapidity than that of the Earth, ſo the alteration in his figure is found to be much more conſiderable, as would naturally follow from ſuch a motion. The relation of his diameters, according to Sir I. Newton, is nearly as 12 to 13; and the difference between his equatorial and polar diameters is about 6230 miles. It is alſo the largeſt of all the planets, and moves in the next orbit to Mars. He performs his annual revolution in rather leſs than 12 years, and his diurnal rotation in about 10 hours. Jupiter, as well as Venus, is ſometimes the morning and evening ſtar. There would not be leſs than 8000 globes like ours neceſſary to form one equal in ſize to that of Jupiter.

SATURN

Completes his annual revolution round the Sun in about 29½ years. The time of his diurnal rotation is not known at preſent; Saturn was conſidered as the remoteſt planet of our ſyſtem, till, on the 13th of March 1781, Dr. Herſchel diſcovered another, ſtill more diſtant from the Sun, round which it revolves in an orbit nearly circular in about 82 years. To this planet he has given the name of the Georgium Sidus.

The planets of each ſyſtem repreſent
Kind neighbours; mutual amity prevails;
Sweet interchange of rays, receiv'd, return'd;
Enlight'ning and enlighten'd! All, at once,
Attracting and attracted! Patriot-like,
None ſins againſt the welfare of the whole:
But their reciprocal, unſelfiſh aid,
Affords an emblem of millennial love.
Nothing in nature, much leſs *conſcious* being,
Was here created ſolely for *itſelf*:
Thus man his ſovereign duty learns in this
Material picture of *benevolence*. YOUNG.

LESSON IV.

THE SATELLITES.

A SATELLITE is a ſmaller or ſecondary planet, which moves round the larger or primary, in the ſame manner as they do round the Sun; there are fourteen of them in number. The firſt of theſe ſatellites is

THE MOON;

The ſilver moon her eaſtern couch forſakes,
And o'er the ſkies her nightly circle makes.
Her ſolid globe beats back the ſunny rays,
And to the world her borrow'd light repays. GAY.

Which, while ſhe is the attendant of the Earth, in its annual progreſs through its orbit, is conſtantly revolving round it; and this revolution ſhe performs in about 29½ days. Her diſtance from the Earth is 24,000 miles. As the ſame face of the Moon is always towards us, it is evident that ſhe turns only once round upon her axis in the time of each revolution round the Earth, ſo that the inhabitants of the Moon (if there be any) have but one day and one night in the courſe of a month. When the Moon is between the Earth and the Sun, ſhe is ſaid to be in conjunction with him: then the whole of her enlightened hemiſphere is turned from the Earth, and ſhe is called a New Moon. When ſhe has advanced through one quarter of her orbit we ſee part of her enlightened hemiſphere in the form of a ſemicircle, and the Moon is then ſaid to be at her firſt quarter. When ſhe has gone through half her orbit, the whole enlightened hemiſphere is towards the Earth, and ſhe is in oppoſition to the Sun, and is called a Full Moon. | The Sun and Moon are at this time in oppoſite parts of the heavens; the Moon riſing in the eaſt as the Sun ſets in the Weſt. When the Moon has proceeded through three quarters of her orbit, ſhe enters her laſt quarter, and again appears ſemicircular. When ſhe has made her revolution, the whole enlightened hemiſphere again becomes inviſible, and we have another *New Moon.* From the New to the Full Moon, the enlightened part is turned towards the weſt, becauſe the Sun is then weſtward of it; but from the Full to the New Moon, it is turned to the eaſt. Juſt before the autumnal equinox, the Full Moon appears larger at her riſing than uſual, and riſes nearly at the ſame hour for ſeveral evenings together, immediately after the Full, and is commonly called the Harveſt Moon. Theſe circumſtances are owing to its peculiar ſituation at theſe periods with reſpect to the Earth; a particular explanation of which is not altogether neceſſary to the young ſtudent in Aſtronomy.

Jupiter has four ſatellites or moons, Saturn ſeven, and the Georgium Sidus two; theſe, like the primary planets, ſhine only by reflecting the light which they receive from the Sun.

Saturn has, beſides his ſeven ſatellites, a luminous or ſhining ring, which encompaſſes

paſſes him; but at ſo great a diſtance from his body, that the fixed ſtars may frequently be ſeen between the inner ſurface of the ring and the planet itſelf. Dr. Herſchel has lately diſcovered that this ring is divided into two parts, an inner and an outer ring, which are ſeparated from each other by a ſpace of one thouſand miles.

The ſatellites of the planets, and Saturn's ring, cannot be ſeen by the naked eye. Jupiter's belts are ſeveral faint parallel ſtripes on his body, ſcarcely diſcernible.

* * *

LESSON V.

COMET.

THIS extraordinary ſtar borrows its name from the vapour with which it is ſurrounded, and is undoubtedly one of the number of celeſtial bodies that belong to the ſyſtem of our world. It moves round the Sun as well as the other planets; but it differs from all of them, by a motion peculiar to itſelf, by its orbit, and by its form. Seen through a teleſcope, it appears full of ſpots and uneven; but the miſt which ſurrounds it often conceals the figure of it. The ſize of comets differs frequently. Some are ſcarce equal to ſtars of the third and fourth claſs. Others, on the contrary, are larger than ſtars of the firſt magnitude. In the middle of it there appears a very thick nucleus, which ſometimes ſeparates, and becomes like the edge of the diſk. Its form is not always perfectly round; nor is the light of it always equally ſtrong and brilliant. Its tail, or beams, always oppoſite to the Sun, are of ſo thin and tranſparent a ſubſtance, that the fixed ſtars may be ſeen through them. Theſe beams extend ſometimes from the horizon almoſt to the zenith, which gives to the whole ſtar an appearance of great diſtinction. The farther the tail is from the Comet, the more it enlarges, and its light decreaſes in proportion as its ſize increaſes.

creaſes./ Sometimes it ſeparates into ſeveral diviſions of rays. This is part of the reſult of ſome exact obſervations made by aſtronomers; but, undoubtedly, it is the leaſt important of what ſhould be known, in order to have a perfect knowledge of all that relates to thoſe celeſtial bodies, many of which are out of the reach of our ſight.

It has been found, from a variety of obſervations, that theſe bodies, which are ſolid and opaque, move round the Sun, and croſs the orbits of the planets in all manner of directions. They are of various magnitudes, like the planets: from which they are known by their long tranſparent tails, which reſemble a pale flame, and iſſue from that ſide of the Comet which is the fartheſt from the Sun. Theſe bodies move in very extenſive orbits like long ovals, of ſuch vaſt circumferences, that at one period of their courſe they are ſo near to the Sun, as to be almoſt melted by his heat, and then go off again to diſtances ſo immenſe, that they muſt be entirely deprived both of his heat and light.

The Solar Syſtem, as deſcribed here, was taught by the philoſopher Pythagoras among the ancients, and was reſtored by Nicholas Copernicus, a Swede, in the year 1473.

The Ptolomæan Syſtem, ſo called from Ptolomæus, an Egyptian philoſopher, ſuppoſed the Earth to be the centre, and that the Sun and Planets moved round the Earth.

The firſt ſyſtem was however demonſtrated by Sir Iſaac Newton to be the true one.

The period of that Comet's revolution which appeared in 1759, was computed at about 70 years, and that which was ſeen in 1680 has been ſhown to have a period of more than 500 years. The orbits of more than fifty Comets have been fixed with ſufficient accuracy to aſcertain when they may be expected to appear.

Some perſons conſider a Comet as the

forerunner of the judgments of heaven. Some read in them the fate of a nation, and the fall of empires. With others, they are preſages of war, of the plague, or of inundations; in a word, of the moſt dreadful calamities. Theſe ſuperſtitious people do not know, that a Comet is a very natural appearance, the return of which can be exactly calculated; and, conſequently, cannot, in any reſpect, interrupt the ordinary courſe of things. They do not conſider, that this ſtar, as well as the planets, muſt have a deſign of very different importance from that which ſuperſtition gives it. What! could Supreme Wiſdom place thoſe prodigious bodies in the ſky, merely to announce to a ſmall number of living creatures the fate that awaits them?

May the Comet (when, overleaping the immenſe ſpace, which now ſeparates it from our ſight, it returns again), may it be to us, not a meſſenger of misfortune, but the herald of the majeſty of God! Let us adore the Supreme Being who preſcribes to it its courſe; who conducts it through immeaſurable ſpace; and orders it ſometimes to approach the Sun, and ſometimes to remove to the fartheſt limits of the planetary ſyſtem.

* * *

LESSON VI.

THE following poetical deſcriptions of the heavenly bodies may not be unacceptable to our young readers.

THE SUN.

Oh, tell a curious mortal all thou ſeeſt;
Say, by what various beings tenanted,
The orbs that borrow thy refulgent blaze;
Made of what matter, moulded to what form,
Bleſt with what organs, with what minds inform'd,
Spurr'd by what paſſions, on what arts intent,
Eager in what purſuits, and by what ties
Combin'd: Oh, ſay, all-ſearching radiance, ſay,
(For doubtleſs moral and immortal all,)
Taught by what diſcipline the generous love
Of beauteous *Virtue*, to what duties call'd.

FAWCETT.

THE MOON.

He ſmooth'd the rough-caſt Moon's imperfect mould,
And comb'd her beamy locks with ſacred gold;
Be thou, ſaid he, queen of the mournful night;
And, as he ſpoke, ſhe roſe clad o'er in light.
COWLEY.

The Moon affords us her alternate ray,
And with kind beams diſtributes fainter day;
Yet keeps the ſtages of her monthly race,
Various her beams, and changeable her face. PRIOR.

THE EVENING STAR.

——With pureſt ray
Sweet Venus ſhines, and from her genial riſe,
When daylight ſickens, till it ſprings afreſh,
Unrivall'd reigns the faireſt lamp of night.
THOMSON.

THE COMET.

Lo! from the dread immenſity of ſpace,
Returning with accelerated courſe,
The ruſhing Comet to the Sun deſcends. THOMSON.

Such are the wonders of creation; who then, but can admire the Almighty hand that formed them!—who, but can humbly reverence

That Pow'r, whoſe providential care
Thro' theſe bright orbs' dark centres darts a ray!
Of nature univerſal threads the whole!
And hangs Creation, like a precious gem,
Tho' little, on the foot-ſtool of his throne! YOUNG.

Names of the Planets.	*Signs of Planets.*	*Periodical Revolutions of the Planets round the Sun.*			*Diurnal Rotations upon their Axes.*			*Mean Diſtances from the Sun.*
		Days.	*Hours.*	*Secds.*	*Hours.*	*Min.*	*Secds.*	*Engliſh Miles.*
Mercury - - -	☿	87	23	15½	*	*	*	37,000,000
Venus - - -	♀	224	16	49¼	23	22	*	68,000,000
Earth - - -	⊖	365	5	49	23	56	4	95,000,000
Mars - - -	♂	686	23	30¾	24	39	22	144,000,000
Jupiter - - -	♃	4332	8	51½	9	56	*	490,000,000
Saturn - - -	♄	10761	14	36¾	*	*	*	900,000,000
Georgium Sidus		30445	18	*	*	*	*	1,800,000,000

LESSON VII.

THE FIXED STARS.

The gems of Heaven, that gild night's ſable throne.
DRYDEN.

——The radiant orbs
That more than deck, that animate the ſky,
The life-infuſing Suns of other worlds. THOMSON.

THE ſtars are ſaid to be fixed, becauſe they never alter their ſituation like the planets; for though the revolutions of the Earth occaſion an apparent motion of the heavens, yet, if any two fixed ſtars be obſerved at ſeveral intervals of time, they will always be found to keep the ſame poſition with reſpect to eath other.

It is ſuppoſed, that theſe ſtars are Suns placed at vaſt diſtances in the immenſe univerſe; each ſhining by its own light, and ſituated in the centre of a ſyſtem, in which planets revolve round them as round our Sun, but too much removed from the Earth to be viſible to us; as their light is only borrowed from their Suns, and is therefore too faint to reach to ſuch a diſtance.

The diſtance of the fixed ſtars from us is ſo immenſe, that even the neareſt of them, the Dog-ſtar, never appears to vary in its dimenſions to us, though the Earth, in its annual revolution, is 195 millions of miles nearer to it when in one part of its orbit than when in that which is oppoſite.

The largeſt of the fixed ſtars are called of the firſt magnitude; thoſe which appear ſomewhat leſs, of the ſecond; and ſo on to the ſixth; theſe are ſuch as are viſible without a teleſcope. The number which may be ſeen with the naked eye at once, is not more than a thouſand; but the numbers which are viſible by means of a teleſcope are very great.

A teleſcope is an inſtrument for viewing the heavenly bodies.

The Galaxy, or Milky-way, is a cluſter

of ſtars which illuminate that part of the firmament.

The heavens are divided into three regions, called the Northern and Southern hemiſpheres, and the Zodiac. The fixed ſtars were claſſed by the ancients under the outlines of certain figures of birds, beaſts, fiſhes, and other animals, called Conſtellations; the number of which is, in the Northern hemiſphere 36, in the Southern 32, and the Zodiac 12. Stars not comprehended in any conſtellation, are called Unformed Stars; and others of a cloudy appearance, are called Nebulæ. Of this number are the Magellanic clouds near the South pole, which reſemble two whitiſh ſpots in the heavens, and are well known to ſailors.

The laſt ſtar in the tail of Urſa Minor, or the Leſſer Bear, is called the Polar Star, and ſerves for a guide to mariners; becauſe, on account of its nearneſs to the North pole, its apparent ſituation, with regard to the Earth, ſcarcely varies through-

out

out the period of the Earth's annual revolution. Two of the ſtars in the conſtellation of Urſa Major, or the Greater Bear, are called the Pointers, becauſe they point to the Polar Star.

During ſome part of July and Auguſt, Sirius, the dog-ſtar, riſes and ſets with the Sun; on which account thoſe days are called the Dog-days.

There are ſeveral little whitiſh ſpots in the heavens which appear luminous, without having any ſtars in them.

One Sun by day, by night ten thouſand ſhine.

The Stella Mira, or Wonderful Star, has appeared and diſappeared ſeven times periodically in ſix years.

Among the ſtars that are eaſieſt to diſtinguiſh, there are ſome which we ſee conſtantly in the ſame part of the ſky, and are always over our heads. Theſe ſerve to guide travellers by ſea and land, in the darkneſs of night. They point out the way to the navigator, and tell him when he may undertake his voyages with leaſt danger. Other ſtars vary their aſpect; and, though they always hold the ſame ſituation as to one another, they change the order of their riſing and ſetting, in reſpect to us, from day to day. Even theſe changes, which never vary in their regularity, are of great uſe to us; they ſerve to meaſure time, and to determine it by ſettled rules. The regular revolutions of the ſtars mark preciſely the return and the end of the ſeaſon. The ploughman knows exactly, by this means, when he ought to ſow ſeeds in the earth, and the whole progreſs of the country labours.

The contemplation of theſe glorious Suns affords to the ſtudious mind very enlarged ideas of the greatneſs of the Almighty, and of the vaſt extent of the univerſe; ſince, had they been formed to illumine the Earth only, it could have received much more light from one ſingle additional Moon. How ſtupendous is the thought, that they beſtow light, heat, and vegetation to a certain number of inhabited planets like our own! But from whence comes it that ſo few conſider the firmament with attention? I am willing to hope that it entirely proceeds from ignorance; for it is impoſſible to be convinced of the greatneſs of the works of God, without feeling the mind forcibly impreſſed with due veneration for his bounty and goodneſs.

Stars *teach* as well as *ſhine!*
——The ſkies
Inform us of ſuperiors numberleſs,
As much, in excellence, above mankind,
As above earth, in magnitude, the ſpheres.
Theſe, as a cloud of witneſſes, hang o'er us;
Awful reflection! ſtrong reſtraint from ill!

* * * * * * *

Who turns his eye on Nature's midnight-face
But muſt inquire—'What hand behind the ſcene,
What arm Almighty, put theſe wheeling globes
In motion, and wound up the vaſt machine?
Who rounded in his palm theſe ſpacious orbs?
Who bowl'd them flaming through the dark profound,
And ſet the boſom of old night on fire?'
Nature's Controller, Author, Guide, and End!
YOUNG.

LESSON VIII.

THE DIURNAL AND ANNUAL MOTIONS OF THE EARTH.

> The day is thine, the night alſo is thine!
> Thou haſt prepared the light and the ſun;
> Thou haſt ſet all the borders of the earth;
> Thou haſt made ſummer and winter. PSALMS.

THE ſucceſſion of day and night is occaſioned by the rotation of the Earth upon its axis, called its diurnal motion, and is performed in twenty-four hours; in that ſpace of time in which we have one day and one night; and the difference of the ſeaſons by the annual motion of the Earth round the Sun.

It will be neceſſary, to enable us to give the young aſtronomer a plain idea of the diurnal and annual motions of the Earth, to deſcribe to him the circles of the ſphere.

An imaginary line paſſes through the

centre of the globe, called its *Axis*; on which it turns round every twenty-four hours.

The oppoſite ends or points of this line are called the Poles of the Earth; the one, the *Arctic*, or North Pole; the other, the *Antarctic*, or South Pole.

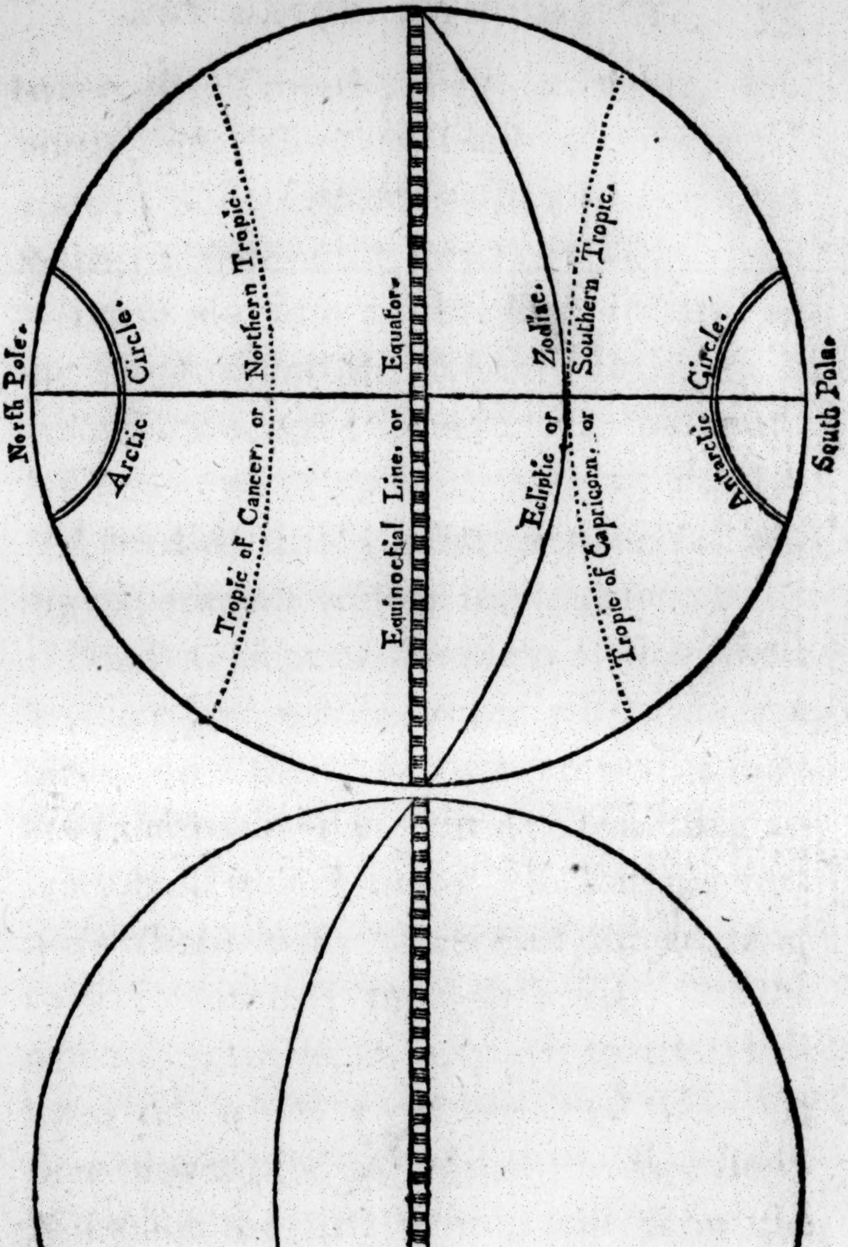
The *Equator*, or *Equinoctial Line*, divides the globe into two equal parts, or hemiſpheres; on this circle the degrees of longitude are marked.

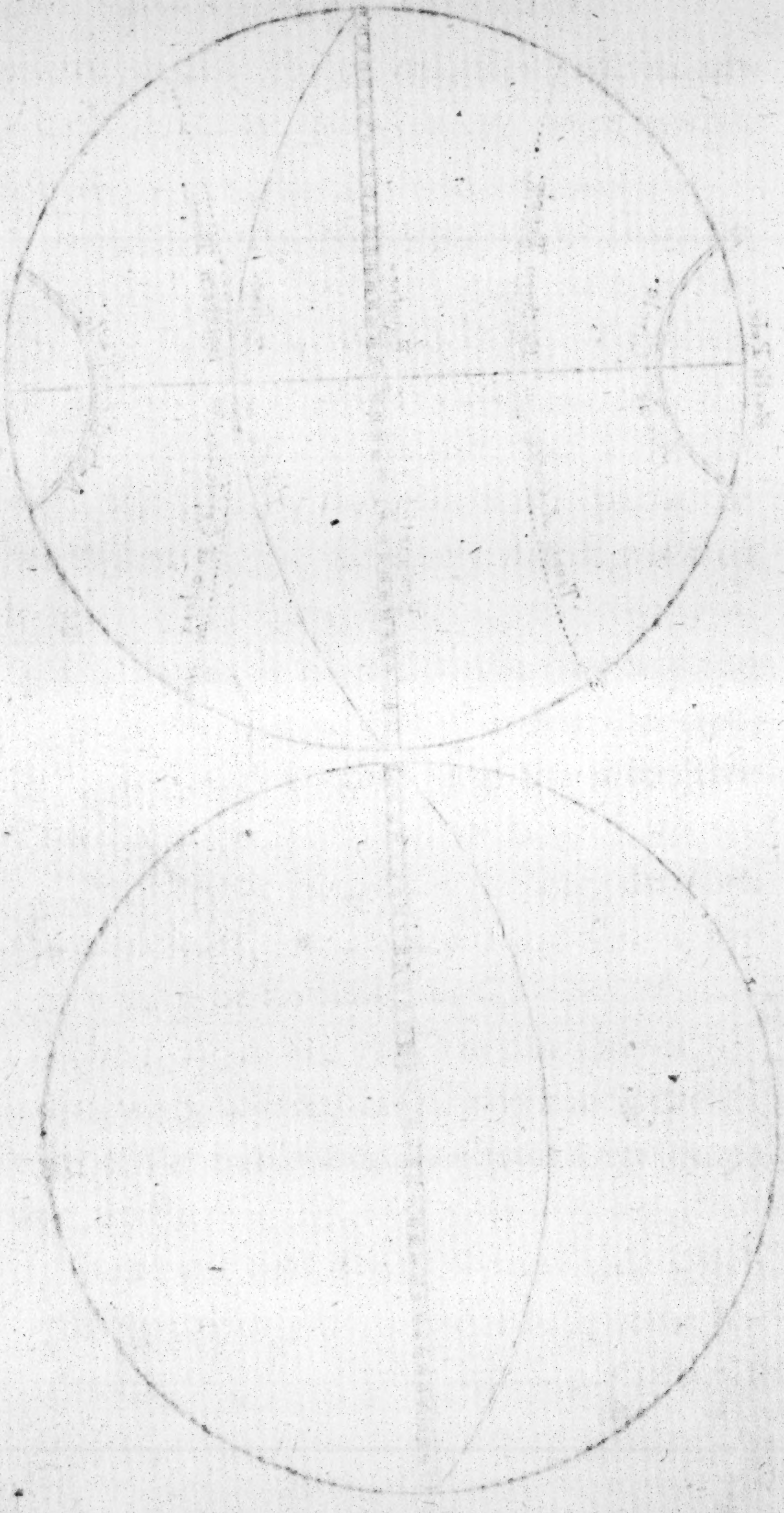
The *Zodiac* is a broad circle that cuts the Equator obliquely. In this are the conſtellations, or ſtars that form the reſpective ſigns.

The *Ecliptic* is a line paſſing through the middle of the Zodiac; and ſhows the Sun's path or annual courſe.

The *Tropics* are two lines or circles parallel with the Equator, and mark the limits of the Sun's motion towards the north and ſouth.

There are five *Zones*: one torrid, which is the ſpace on either ſide the Equator between


North Pole.
Arctic Circle.
Tropic of Cancer, or Northern Tropic.
Equinoctial Line, or Equator.
Ecliptic or Zodiac.
Tropic of Capricorn, or Southern Tropic.
Antarctic Circle.
South Pole.



tween the Tropics; two temperate, one north and the other ſouth of the torrid zone; and two frigid, northern and ſouthern, within the polar circles.

There are alſo thirty climates between the Equator and the North Pole, and as many between the Equator and the South Pole.

After this little illuſtration, the following experiment will be found eaſy.

Bend a piece of wire into a circle, and let ſome perſon hold it even with a candle placed on a table, ſo that the candle may be exactly in the centre; then ſling an ivory ball (which may be had at any turner's ſhop) with a piece of thread, and twiſt it towards the left hand, ſo that when it untwiſts, it may go to the eaſtward or to the right hand, at the ſame time moving the ball round the wire ſlowly; when the firſt motion will ſhow the days and nights, and the other the annual motion of the Earth: but in this caſe, the days and nights would be equal, and the ſeaſons alike, which is not the caſe, as the

Earth's orbit, repreſented by the wire, ſhould be inclined to the Equator, a circle ſuppoſed to be drawn round the globe, in an angle of twenty-three degrees and a half; therefore, let the perſon who holds the wire raiſe it up at one ſide and depreſs it on the other, ſo that the candle may ſtill be exactly in the middle; then let the ball down to the lower part of the wire, and the candle, which repreſents the Sun, will ſhine on the tropic of Cancer, and on all the countries from the Equator to the North Pole, which will have longer days and ſhorter nights, and thoſe countries towards the South Pole exactly the reverſe. In thoſe countries ſituated on the Equator, the days and nights are equal.

When to the weſtern main the Sun deſcends,
To other lands a riſing day he lends;
The ſpreading dawn another region ſpies,
And o'er th' Antipodes* begins to riſe:
While we in ſleep's embraces waſte the night,
The climes oppos'd enjoy meridian light;
And when thoſe lands the buſy Sun forſakes,
With us again the roſy morning wakes. — GAY.

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* Thoſe people are called Antipodes, who, living on the other ſide of the globe, have their feet directly oppoſite to ours.

LESSON

LESSON IX.

ECLIPSES.

Shorn of his beams, the Sun
In dim eclipſe diſaſtrous twilight ſheds. MILTON.

The ſilver Moon is all o'er blood;
A ſettling crimſon ſtains her beauteous face. LEE.

AN eclipſe of the Sun is occaſioned by the Moon's paſſing between it and the Earth, and thereby hiding the light of the Sun from the Earth; which can never happen, but when the Moon is in conjunction with the Sun; that is, at the New Moon.

Conjunction is the meeting of the Stars or Planets in the ſame degree of the Zodiac, or when a right line drawn from the eye through the centre of one of the bodies would paſs through that of the other.

An eclipſe is called annular, when the Moon is ſo ſituated, that its ſhadow, being leſs than the diſk or face of the Sun, conceals only its centre from our ſight; whilſt the edge of the Sun appears like a bright ring all around it.

The lunar eclipſe of the Moon is occaſioned by the Earth's paſſing between the Sun and the Moon; whereby the Moon is darkened, as it is thus deprived of the light of the Sun. This can only happen when the Moon is in oppoſition to the Sun; that is, at the Full Moon.

Oppoſition is that aſpect or ſituation of two planets, wherein they are diametrically oppoſite to each other.

The Moon is ſeldom entirely dark even in a total eclipſe; which is ſaid to be owing to the Sun's rays being refracted, or bent inwards, in paſſing through the atmoſphere of the Earth.

The reaſon the Sun is not eclipſed every New Moon, and the Moon every time ſhe is Full, is, that the Moon's orbit is inclined to the plane of the ecliptic; ſo that an eclipſe can never happen, but when the Moon is either in or near one of the nodes;

which are the two points in which the orbit of the Moon cuts the ecliptic.

A lunar eclipſe appears the ſame in all parts of the world where the Moon is viſible at that time; but a ſolar eclipſe will appear differently in other places.

An eclipſe of the Moon always begins on her eaſtern ſide, and an eclipſe of the Sun begins on his weſtern.

The greateſt number of eclipſes of both luminaries which can happen in a year, is ſeven; and the leaſt, two; the moſt uſual number is four: and there are very ſeldom more than ſix, one half of which are moſtly inviſible at any particular place.

The diameters of the Sun and Moon are divided by aſtronomers into twelve equal parts, which they call digits; and an eclipſe is ſaid to be of ſo many digits, according to the number of thoſe parts which are involved in darkneſs.

LESSON X.

THE TIDES.

THE ocean, it is well known, covers more than one half of the globe, and this large body of water is ſound to be in continual motion, ebbing and flowing alternately, without the leaſt intermiſſions:—for inſtance, If the tide be now at high water mark in any port or harbour which lies open to the ocean, it will preſently ſubſide and flow regularly back for about ſix hours, when it will be found at low water mark. After this it will again gradually advance for ſix hours, and then return back in the ſame time to its former ſituation, riſing and falling alternately twice a day, or in the ſpace of about twenty-four hours. This is chiefly owing to the Moon, which paſſing over any particular part of the ocean, attracts and raiſes the waters in that place. She likewiſe produces the effect of raiſing the water, both upon that part over which ſhe is paſſing, and upon that which is immediately oppoſite.

The Sun likewiſe affects the tides in ſome degree; and when at the time of the New and Full Moon, the Sun and Moon acting together upon the water, elevate it more conſiderably, they are called *Spring-tides*; but at the Moon's firſt and laſt quarters, the Sun and Moon acting contrary to each other, the water does not then riſe ſo high; and theſe are called *Neap-tides*.

The effect of the Moon upon the water does not appear till three hours after ſhe has paſt the meridian of the place.

Various cauſes concur in different ſeas and channels, that make conſiderable deviations from the general rule reſpecting the tides.

Kepler, a German, was the firſt who diſcovered the cauſe of the tides; but his theory was conſiderably improved by Sir Iſaac Newton (our own countryman), the greateſt aſtronomer that ever the world produced.

> Let Newton, pure intelligence! whom God
> To mortals lent, to trace his boundleſs works,
> From laws ſublimely ſimple, ſpeak thy fame
> In all philoſophy. THOMSON.

* * *

LESSON XI.

OF THE ELEMENTS, AND OF THE ANIMAL, VEGETABLE, AND MINERAL KINGDOMS.

Oh Lord! how manifold are thy works! in wiſdom haſt thou made them all; the earth is full of thy riches.

> Th' informing Author in his works appears.
> THOMSON.

THERE are four elements, Earth, Air, Fire, and Water. The productions of the Earth are divided into three claſſes—the animal, vegetable, and mineral kingdoms.

The animal kingdom compriſes every

creature endued with both life and ſenſation; viz. men, beaſts, birds, fiſhes, inſects, &c.

The vegetable kingdom comprehends ſuch things as have life without ſenſation; as trees, ſhrubs, flowers, herbs, graſs, &c.

The mineral kingdom conſiſts of ſuch things as have neither ſenſation nor life; as ſtones and metals. Minerals are alſo called foſſils, and are claſſed under the following heads: Salts, as potaſh, ſoda, and ammoniac. Earths, &c. ſtones, as well rocks as precious; theſe are lime, flint, clay, magneſia, &c. Metals, which are twenty in number; and Inflammables, as coal, bitumen, ſulphur, &c.

Ores are metals as they are firſt dug out of the mines, before they have gone through any proceſs to ſeparate them from the earth, and other ſubſtances which are mixt with them originally.

> Thus with a faithful aim have we preſum'd,
> Adventurous, to delineate Nature's form,
> Whether in vaſt majeſtic form array'd,
> Or dreſt in pleaſing wonder. THOMSON.

———All, all, is miracle, but ſeen
So dully, all is miracle, in vain.
What prodigies can power divine perform,
More grand than it produces year by year,
And all in ſight of inattentive man?
Familiar with th' effect, we ſlight the *cauſe!*
And in the conſtancy of nature's courſe,
The regular return of genial months,
And renovation of a faded world,
See nought to wonder at, or, when we do,
Forget to praiſe the Author! COWPER.

* * *

LESSON XII.

GRAVITY.

'Tis by the ſecret, ſtrong, attractive force,
As with a chain indiſſoluble bound,
Thy ſyſtem rolls entire. THOMSON.

THE Sun attracts the planets, the Earth and Moon; thus it is called the Centre of Gravity. Gravity is the power which a greater body has of attracting a leſs; by this attraction, the Earth with the other planets would fall into the Sun, did they not go with ſuch velocity through the Heavens, as to make the one power equal to the other, which makes them always preſerve the ſame diſtance, beſides which they mutually attract each other. This may be very eaſily exemplified by a boat in the water faſtened to a ſhip: while one man pulls the rope to try to bring the ſhip and boat together, let another endeavour to row it off ſideways; when the former man, inſtead of being able to draw the boat to the ſhip, will find it enough for him to keep the boat from going further off. Here the ſhip repreſents the Sun, and the boat the Earth; the man who pulls the rope, the power of gravity, and the man who rows, the power which keeps the Earth in its ſtation.

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LESSON XIII.

OF LIGHT AND AIR.

LIGHT conſiſts of inconceivably ſmall particles of matter, emitted from the ſurface
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face of a luminous body, in right lines, and in all directions, with an unparalleled velocity. It is likewiſe ſo exceedingly fine and ſubtile, that it penetrates through glaſs, and is diffuſed over the whole world.

Theſe amazing ſmall particles, by ſtriking upon our eyes, excite in the mind the idea of light; but if they were only as large as the leaſt particles diſcernible by a microſcope, they would deprive us of ſight by their velocity—ſo admirably has the Divine Wiſdom diſpoſed every thing for the good of mankind.

A microſcope is an inſtrument, by means of which, very minute objects may be diſtinctly viewed.

OF AIR.

Air is that thin fluid maſs of matter in which we live and breathe. The air is juſtly reckoned a fluid, ſince it yields to the leaſt force impreſſed, and its parts are eaſily moved among one another.

Air is the element to which all this lower world owes its life, beauty, and preſervation. All the changes we obſerve in the different beings our globe contains, depend on air. Plants, even, in order to vegetate and grow, require air, and have therefore a multitude of little veſſels, which ſerve to draw it in, and by means of which, even the ſmalleſt particles of them are provided with all the neceſſary juices.—Nothing would be more eaſy than to multiply proofs of the neceſſity of air. Let us dwell on one ſingle circumſtance only, which demonſtrates it very clearly: if there was no air, there would be no twilight before ſunriſe. It would come ſuddenly above the horizon; would appear the ſame as it does towards the middle of its courſe, and would not vary its appearance till the inſtant it would vaniſh entirely from our ſight, leaving us in as total darkneſs as at midnight.

The weight or preſſure of air is determined by an inſtrument called the Barometer.

LESSON XIV.

THE BAROMETER EXPLAINED.

THE Barometer is uſed in foretelling the changes of the weather. It conſiſts of a glaſs tube, cloſed and filled with mercury at one end, and purged of its air; the finger being then placed at the open end, in contact with the mercury, ſo as not to admit the leaſt particle of air, the lower end of the tube is plunged in a ſmall baſon of the ſame prepared mercury, and, upon removing the finger, the mercury in the tube will join that in the baſon, and the column of mercury in the tube will ſubſide to the height of 29 or 30 inches, or thereabouts, 29½ inches being the mean ſtate of the atmoſphere; this is the principle of all barometers, which was diſcovered by Torricelli, Gallilæo's diſciple; but it was ſome time afterwards before the variations in the height of the mercurial column were obſerved and marked, or that theſe changes were obſerved to be ſucceeded by changes in weather.

The barometer is furniſhed with a ſcale, on which are marked the variations. The riſing of the mercury in general preſages fair weather; if inclined to rain, the mercury is commonly low; in great winds, accompanied with rain, it ſinks loweſt of all; but in froſty weather it moſtly ſtands high: theſe are, however, very general obſervations.

Since then in a mean ſtate of the air the mercury ſtands at 29½ inches, if the tube were a ſquare inch wide, it would at that height contain 29½ cubic inches, which is juſt fifteen pounds; and ſo much weight of air every ſquare inch of the earth's ſurface ſuſtains. At this rate, a middle-ſized man, whoſe ſurface is about fifteen ſquare feet, is preſſed by 32,400 pounds of air; but this enormous weight is equal on all ſides, and counterbalanced by the ſpring of the air diffuſed through the whole body, which re-acts with an equal force againſt the outward preſſure.

We look upon the air in general as altogether inviſible; and it ſhould be ſo, as it is the medium through which we ſee objects; if the parts of air were perceptible, it would render the view of objects leſs perfect and diſtinct. With reſpect to the height of the air, is this, that the denſity of it, at the height of about forty-five miles, is but juſt ſufficient to inflect, or bend, a ray of light out of its right-line courſe, which is the leaſt effect it can produce, and therefore all beyond that height muſt be eſteemed an unreſiſting *æther*.

Wind is no more than air in motion.

The weight of air, in the animal economy, is like the weight of a clock in mechanics, which gives motion to all the machinery. Air, by its preſſure, ruſhes into the lungs of all animals, ſets thoſe noble ventilators to work, communicating, by that means, a vital principle to the blood; in like manner, the air is every way neceſſary for vegetation: the bodies of plants, as well as animals, are ſo organized as to circulate this neceſſary fluid.

The air, together with the clouds and vapours, form what is called the Atmoſphere, which we ſhall next notice.

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LESSON XV.

THE ATMOSPHERE,

A THIN fluid maſs of matter, which gravitates or adheres to the Earth in all its revolutions, and is thinner or more rarefied, the higher it is from the Earth's ſurface.

Dr. Keil, a great aſtronomer, has obſerved, that it is owing to the atmoſphere that the Heavens appear bright in the day-time; for without one, if we turned our backs towards the Sun, the ſpace before us would be as dark as night; but the atmoſphere diffuſes light all around. Twilight
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light is owing to the atmoſphere, which reflects the light of the Sun to us, before he riſes or appears above the horizon: by the ſame reaſon, it continues to be light ſome time after the Sun has ſet.

The atmoſphere refracting or bending the Sun's rays, brings him in ſight every clear day before he riſes in the horizon, and keeps him in view ſome minutes after he is really ſet below it. This effect may be exemplified, by putting a ſhilling into an empty baſin, and placing yourſelf at ſuch a diſtance from it, as that the edge may conceal the ſhilling from you; if ſome perſon then fills the baſin with water, you will ſee the bottom of the baſin and the ſhilling, by means of the refraction occaſioned by the water: ſo it is with the Sun and the atmoſphere.

It is a common, but erroneous obſervation, when people feel themſelves languid, to ſay, the air is heavy, when the fact is, it is too light, not being able to bear up the vapours and clouds; for if the air was more elaſtic and weighty, it would mount the clouds higher, and we ſhould feel briſk and lively.

The height of the atmoſphere (ſo far as it is denſe enough to reflect light) has been calculated to be about forty-four miles; but is ſeldom denſe enough at two miles height to bear up the clouds.

The wonderfulneſs of the regions of air above the clouds has been beautifully deſcribed by the ingenious Mr. Baldwin, who in his excurſion in the air-balloon was apparently many miles above all viſible vapour. He obſerves, that "a cheerful ſerenity filled his breaſt; he tried his voice, and ſhouted for joy; his voice was unknown to himſelf, ſhrill and feeble:" the clouds below him reſembled "a *ſea of cotton*, but more *white* and dazzling:" the whole formed a glorious concave, and the imagination was loſt in the ſurrounding diſtant azure.

Such was the ſituation of the aëronaut, whoſe philoſophical mind, ſo far from feeling ſear, indulged "*exquiſite delight and rapture*;" the effect, no doubt, of the new wonders he witneſſed, and the enchanting diſcoveries he made.

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LESSON XVI.

ELECTRICITY.

THE earth and all bodies are ſuppoſed to contain a certain elaſtic and ſubtle fluid, which philoſophers call Electric.

While each body poſſeſſes its natural ſhare of the electric fluid, it is wholly dormant, and produces no ſenſible effect; but the moment any body becomes poſſeſſed of more than its natural quantity, very remarkable effects ariſe from it, and it is ſaid to be electrified.

The dormant ſtate of bodies could never be diſturbed (or, if diſturbed, would be immediately reſtored), but that ſome of them do not admit the paſſage of the electric fluid through their pores.

A conductor is a body through which the electric fluid can paſs, as metals of all ſorts.

A non-conductor, that through which it cannot paſs, as glaſs, roſins, ſealing-wax, and air.

An idea of electricity may be thus obtained: draw a glaſs tube through the hand; when the effect of the friction is, that the electric matter leaves the hand and paſſes to the glaſs, where it remains as an additional quantity to that the glaſs poſſeſſed before; for as neither the glaſs nor the air are conductors, the electric matter cannot get away; but if the glaſs is touched by a piece of metal, or any conducting ſubſtance, it will immediately paſs into them, till it becomes diſcharged of its more than natural ſhare of the electric fluid.

The electric attraction and repulſion may be explained to the young mind in a very pleaſing experiment, by means of a glaſs tube and feather; when the tube is overcharged, or, as it is called, excited by the friction of the hand, the feather, when brought near it, will be attracted, and jump to the tube, where it will remain till it gets filled with electric matter, when it will ſuddenly jump from it, and if the electrified tube be held under it, it will be driven into the middle of the room, where it may be kept ſuſpended, or ſent about in any direction you pleaſe, if the air is dry. The electric phenomena of attraction and repulſion may be alſo exhibited by ſealing-wax and amber.

Thales, the Mileſian, who lived ſix hundred years before Chriſt, firſt obſerved the electric properties of amber.

Dr. Gilbert, an Engliſh phyſician, who lived in the ſeventeenth century, firſt made electricity a ſtudy; diſcoveries were afterwards made by Boyle and Sir Iſaac Newton, and many late improvements in the ſcience, by the celebrated philoſophers

Dr. Franklin and Dr. Prieſtley, Mr. Cavallo, and ſeveral others.

LESSON XVII.

MAGNETISM

IS the virtue or power of the magnet, or loadſtone, which is a very rich iron ore found in maſſes, and has the power of attracting or repelling iron.

A piece of iron placed near one end of a magnet will immediately move forward till it touches it; and if you then lift up the magnet, the iron will appear to be ſuſpended to it, and will remain ſo till removed. Every magnet has what are called its North and South poles; one of which repels the ſame piece of iron the other attracts.

The Mariner's Compaſs is an inſtrument of great uſe at ſea; it has a kind of dial-plate divided into thirty-two equal parts by right lines drawn from the centre to the circumference: theſe thirty-two points are called the Points of the Compaſs; and the four principal ones, viz. Eaſt, Weſt, North, and South, are denominated the Cardinal Points. Over this dial-plate is ſuſpended a thin piece of iron, which, by being touched by a magnet or loadſtone, acquires the magnetic quality, whereby its two poles are made to point nearly to the North and South poles of the world. This is called the Needle; and is of the greateſt conſequence to Navigators, who regulate the courſe of the ſhip by it.

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LESSON XVIII.

THUNDER AND LIGHTNING.

> The Lord thundered in the Heavens, and the Higheſt gave his voice; his lightnings enlightened the world.

THUNDER, properly ſpeaking, is neither a phenomenon, nor a meteor, as it conſiſts altogether in ſound.

The cauſe of thunder puzzled the philoſophers a long time, till the ingenious Dr. Franklin removed the difficulty, by ſhowing, that it is nothing more than the electric fluid darting from the clouds in which it is collected: from the Doctor's experiments it appears that lightning is only electrical fire, drawn off from the clouds; a cloud prepared by heat or exhalations is the electric body; and watery clouds or terreſtrial matter, the non-electrics which excite it.

The *Thunder-bolt* muſt ever fill the mind with awe, as by its ſtroke the ſtrongeſt trees are rent aſunder, the fineſt buildings demoliſhed, and the hardeſt metals in a moment melted. The ſubſtance of theſe bolts conſiſts of a compact and undiſſolvable body of ignited matter, which has not time to explode in the air, but is darted with the velocity of light itſelf to the objects on the ſurface of the earth.

Lightning may be conſidered in three different ſtates; the firſt is, that in which it only explodes, and flaſhes away without force to do harm; the ſecond is, when it explodes with greater force and denſity, ſtriking unhappy ſpectators blind, ſetting fire to ſtacks of corn, houſes, &c.; and the third ſtate is that of the *Thunder-bolt*.

——Oft from the jarring clouds,
Darting in dizzy whirl, tempeſtuous rolls
The deep-mouth'd thunder thro' the darkſome vault
Of Heaven: the winds attend it, and the ſkies
From their wide ſluices pour a torrent down,
Ruſhing impetuous. OGILVIE.

We hear the winds blow, we ſee the vapours riſe, and obſerve the clouds driven about in the air; the deſcending ſhowers of rain often alarm us; froſt and ſnow make us ſhudder at the change of the ſeaſons; and the *awful* phenomena of thunder and lightning ſeldom fail to raiſe our trembling admiration of the wonders of omnipotent power; but after they ceaſe, and the air becomes ſerene and calm, our amazement ceaſes with the cauſe, and we leave it to the buſineſs of *philoſophers* to be acquainted with *natural things*, as if every reaſonable perſon were not concerned to regard " *the works of the Lord.*"

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LESSON XIX.

METEORS.

METEORS are fiery, airy, and watery.

FIERY METEORS.

We learn from Sir Iſaac Newton, who alone has reaſoned juſtly concerning the nature of *fire*, the beſt account of *Fiery Meteors*; he informs us, " By the conſtant heat of the Sun in the ſummer time, great quantities of exhalations, from ſulphureous and other combuſtible matters, are raiſed in the upper regions of the air, and theſe meeting and mixing with the nitre, an incaleſcence will immediately enſue, and oftentimes real accenſion, or production of flame; and this, if it happens in the evening or night-time, is what is called Lightning, if it happens in any one particular part of the Heavens only; but when the atmoſphere is more generally replete with theſe combuſtible exhalations, they make a more general conflagration, and burn with one continued flame, illuminating every part of the Heavens in a tremendous manner; this the philoſophers call the *Aurora Borealis*, or Northern Lights."

AIRY METEORS,

As winds, tornadoes, &c. are occaſioned by the unequal temperature of the air, ariſing from the action of heat and cold.

WATERY METEORS

Are vapours, or watery particles, variouſly modified by heat or cold; as clouds, rain, hail, ſnow, and dew.

FALLING STARS

Are alſo vapours kindled in the air; often very near the ſurface of the earth, and ſometimes much higher.

It has been generally imagined, that there ariſes ſometimes in marſhes and other moiſt places, a meteor, like the flame of a candle; which has been called the *Ignis Fatuus*, and vulgarly, *Will-with-a-wiſp*, or *Jack-with-a-lantern*; but the exiſtence of this meteor is at preſent doubtful.

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LESSON XX.

AURORA BOREALIS.

YOU may often have obſerved in winter, towards the ſpring equinox, a ſort of tranſparent, bright, and variegated clouds in the ſky. From the north there appears a ſplendid light, which comes cloſe to the other clouds. From theſe northern clouds there dart white rays of light, which reach to the zenith. This ethereal phenomenon, called Northern Lights, or Aurora Borealis, is ſtill, in ſome reſpects, one of thoſe natural effects, the cauſe of which cannot be very exactly determined. Some naturaliſts ſuppoſe it to be a magnetic ſubſtance, which, gathering and thickening towards the north, may ſhed a certain light at a diſtance. Philoſophers pretend, that it is only the atmoſphere inflamed, and a ſtorm not yet come to maturity. The uncertainty in which the beſt informed and moſt learned men are, in reſpect to it, is very inſtructive to us. How many things do we ſee in the air, in the ſky, and upon earth, which are ſtill myſteries, even to the moſt learned! Theſe things, therefore, ought to humble the human mind, whoſe pride and vain curioſity often prevent it acknowledging how limited its faculties are. A thouſand trifling things confound the moſt learned in their meditations, and eſcape our inquiries. There are a thouſand objects, which, indeed, we acknowledge to be planned with much wiſdom, and to be very uſeful; but we ſeldom arrive at diſcovering their true principles, their purpoſe, their connexion with the corporeal world and its ſeveral parts. However, this ignorance does not affect our happineſs; and though, for example, we cannot exactly determine from whence the Aurora Borealis proceeds, we can live quietly and well without it. After all, ignorant as we may be on this point, and a number of others, we know, at leaſt, that every phenomenon of the phyſical and intellectual world, happens only by the will of an all-wiſe, almighty, and perfect Being, who directs them for the good of the univerſe.

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LESSON XXI.

THE EARTHQUAKE.

Earth felt the wound, and nature from her ſeat,
Sighing through all her works, gave ſigns of woe.
MILTON.

AN earthquake is a violent agitation or trembling of ſome conſiderable part of the
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Earth, attended with a terrible noiſe like thunder, frequently with an eruption of fire, water, wind, &c. They are occaſioned by the vaſt quantities of ſulphur and nitre, contained in ſubterraneous caverns of the Earth, which inflammable matter ſometimes takes fire of itſelf, and goes off with a ſudden exploſion, lifting the ground above it, and making the moſt dreadful havoc and devaſtation.

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LESSON XXII.

SUBTERRANEOUS FIRES.

By digging a little deep into the earth, a greater degree of cold is felt than on the ſurface: becauſe the latter is heated by the ſun. From thence it is, that the inhabitants of hot countries can preſerve ice to cool their drink the whole year. But if they dig fifty or ſixty feet deep, the heat increaſes ſenſibly, and, if it is ſtill a greater depth, it becomes ſo cloſe, that it ſtops reſpiration, and puts out a candle. It is not eaſy to determine the cauſe of this heat. Thoſe who admit that there are concealed fires in every place under the earth, approach, perhaps, the neareſt to the truth. But how this fire, ſo cloſely confined, can burn; what the ſubſtance is that feeds it; or how it can be burned without conſuming, is what cannot be determined with certainty. There are phenomena on our globe, which prove the exiſtence of ſubterraneous fires in a very formidable manner. From time to time there are terrible eruptions of fire. The two moſt remarkable mountains which produce ſuch, are Ætna in Sicily, and Veſuvius in the kingdom of Naples. The accounts given of theſe two volcanos are frightful. Sometimes a black vapour only riſes out of them; at other times, a hollow roaring is heard; all at once it is followed by thunder and lightning, attended by an earthquake. Then the vapour clears up, and becomes luminous. Stones fly out with violence, and fall again into the gulf from whence they came.

But wherefore theſe volcanos, which ſpread ſuch terror and devaſtation on the earth? Why has the Lord created them? Why, inſtead of putting bounds to their fury, has he permitted them thus to diſtreſs his creatures?—Who then am I to dare to aſk ſuch queſtions? Have I a right to demand an account of the plans formed by Supreme Wiſdom? The exiſtence of thoſe volcanos cannot be the work of chance; and I ought to conclude, that the Creator has wiſe reaſons for ordering ſuch to be.

The boſom of the earth being full of fire, it was abſolutely neceſſary that there ſhould be volcanos, becauſe they are the vents by which the force of the dreadful element is broken and weakened. And though the countries where the ſubterraneous fires collect in greateſt quantities, are ſubject to earthquakes, they would be ſtill more violent, if theſe volcanos did not exiſt. Italy would not be ſuch a fertile country, if, now and then, the fire which the earth contains had not found a vent in thoſe mountains.—At leaſt, this is enough to convince us, that they contribute to fulfil the deſigns of our divine Author, ſo full of wiſdom and goodneſs.

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LESSON XXIII.

USES OF FIRE.

FIRE is, in ſome degree, the univerſal inſtrument of all the arts, and all the neceſſaries of life. In order that man ſhould make continual uſe of this element, the Creator has cauſed it to mix in the air, the water, and all fat and oily ſubſtances.

How very uſeful is all the combuſtible matter which ſupplies us with fuel! Without a ſufficient proviſion of it, we ſhould not only loſe the greateſt advantages, but we ſhould be expoſed to the greateſt inconvenience.

Without that element, we ſhould not be able to melt metals, to make them malleable, to refine them; to change ſand into glaſs; or to give to lime the conſiſtence of ſtone.

Without fire, nature and all its treaſures would become uſeleſs, and would loſe in our eyes the moſt of their charms. But let us limit ourſelves to the advantages which we gather from it. What comfort we find in a room warmed by it, ſo as to guard us from the impreſſion of the outward air! During hard froſts we ſhould be condemned to do nothing, at leaſt to a thouſand diſagreeable ſenſations, if the fire did not convey to us a certain activity.

——Within Earth's womb
Are veins of living fire; impriſon'd air;
Nitre with ſtrong bitumen, winding ſtreams,
That through the echoing cavern loudly roll,
And form the ſmoky ſulphur; theſe o'er the maſs
Diffuſive ſpread, and when the ſtruggling air,
Pent up and ſtraighten'd, works them into flame,
All wild and rapid, through the labouring Earth
They pour reſiſtleſs; burſt the ſolid cliffs,
And through the yawning void, that whelms at once
The tumbling city, mount and melt in air.

OGILVIE.

LESSON XXIV.

THE WIND.

He rode upon the cherubims, and did fly; he came flying upon the wings of the wind.
He giveth ſnow like wool, and ſcattereth the hoarfroſt like aſhes.

——The South Wind night and horror brings,
And fogs are ſhaken from his flaggy wings;
From his divided beard two ſtreams he pours;
His head and rheumy eyes diſtil in ſhowers;
With rain his robe and heavy mantle flow,
And hazy miſts are lowering on his brow.

DRYDEN'S OVID.

WIND,

IN a general way of defining it, is only *air* in *motion*, though in itſelf it is both a curious and important ſubject, and has employed the moſt learned pens of philoſophers to account for it; need it be mentioned of the ineſtimable benefit it is to all mankind?—as air without *motion* is as pernicious as ſtagnated water, and would prove equally dangerous to the health and life of every one. The dreadful effects of a moa motionleſs air we find in priſons, ſhips, &c. *Ventilators*, and other methods propoſed for producing a motion and circulation of air, are of the utmoſt importance, and ſhould never be diſpenſed with in any caſe.

A ſhip is one of the nobleſt machines, and the greateſt effect of art that has relation to the motion of air. The oceans would of themſelves be uſeleſs to us without the moving air; the ſhip might ſwim in them, but not ſail, without *wind*; our goods to foreign countries, and the riches of the *Indies* are wafted to us on the gales of wind that fill the ſails of our ſhipping.

Wind is the conſequence of the air being rarefied, or made to ſwell with heat.

When the air is much heated, it aſcends towards the upper part of the atmoſphere, and the adjacent air ruſhes in to ſupply its place; and therefore there will be a current of air from all parts towards the place where the heat is.

Upon this principle we may account for

the trade winds, which blow from eaſt to weſt, near the equator; for where the Sun ſhines perpendicularly, the air will become heated, and will riſe upwards, when the adjacent cooler air will ruſh in to ſupply its place: and as the Sun, with reſpect to the earth, moves from eaſt to weſt, the courſe of the air will be that way, conſtantly preſſing after the Sun; therefore, at the equator, there will be a wind from the eaſt, but on the north ſide it will incline a little to the north, and on the ſouth ſide to the ſouth.

The irregularities of winds are chiefly owing to the falling of great quantities of rain, to exhalations, to high mountains, which alter their direction, and to the declination of the Sun north or ſouth.

The benefits ariſing from the winds are almoſt innumerable: they purify the air, moderate the heat, dry wet lands and damp houſes, chaſe away the fogs and hazy weather, and bring us the rain in due ſeaſon.

LESSON XXV.

PROPERTIES OF SOUND.

ALL ſounds are produced by means of the air; but it is neceſſary for that purpoſe, that the air ſhould be in motion. It is not that every movement of the air occaſions a ſound, for, if this were the caſe, all wind muſt be attended by a noiſe. In order to form a ſound, the air muſt be ſuddenly compreſſed, and muſt dilate and extend again by its elaſtic power: this occaſions a kind of trembling undulation, ſomething like that of the waves and circles occaſioned by throwing a ſtone into the water. But if this undulating motion were only to be effected by the particles of air being compreſſed, the ſound would never reach our ears. It is neceſſary that the ſonorous bodies, after making impreſſion on the contiguous air, ſhould continue that impreſſion from particle to particle circularly all about us. By theſe means the particles of air reach our ear, and we have a perception of ſound. This progreſs is made with prodigious ſwiftneſs, as ſound goes a thouſand feet in a ſecond of time.

A thin elaſtic membrane, ſtretched at the bottom of the ear, like a drum, receives the vibration of the air; and by that mean we have the power of diſtinguiſhing all ſorts of ſounds. Thus far our knowledge reaches.

If there were no ſounds, all mankind would be dumb, and we ſhould be as ignorant as a child before it can ſpeak; but by means of ſounds, every creature can expreſs its wants and its enjoyments. Man has, in this reſpect, great advantages: he can expreſs the ſentiments of his heart; and even excite the paſſions by certain tones of his voice. God has not only endowed us with the faculty of diſtinguiſhing ſounds by the organs of hearing, but he has alſo furniſhed us with other means of preſerving this bleſſing: if one ear ſhould be hurt, the other ſtill may do its office.

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LESSON XXVI.

COLOURS.

WHEN we conſider how dull and melancholy the country would be, and how confuſed all objects would appear, if they were of one colour, we muſt acknowledge the wiſdom and goodneſs of God, who, by variety of ſhades and colours, meant to increaſe and vary our pleaſures on earth.

But whence proceeds the diſtinction of colours? Each ray of light appears to be ſimple; but, by refraction, it divides into ſeveral; and it is hence that colours ariſe. A glaſs of water laid in the Sun reflects certain colours on white paper: angular glaſs, well cut and poliſhed,

liſhed, caſts ſtill more lively colours. But we ſhould ſee the fineſt rainbow cloſe to us, if we turn a priſm towards the Sun, or if with the priſm (or triangular glaſs) we receive a ray, entering by a little hole into a cloſe-ſhut room. The colours are in proportion more or leſs bright, according as the refraction of rays is more or leſs ſtrong. This may make us comprehend whence proceeds the variety of colours: the whole is compriſed in this, that the ſurface of bodies is compoſed of extremely ſmall flakes, which, according to their different thickneſſes, reflect ſome coloured rays, while they admit or abſorb others in their pores. Thus, when a body, whoſe ſurface is ſmooth, reflects and throws out almoſt all the rays of light, it appears *white*; and when, on the contrary, it abſorbs them, it is *black*. Let us in this admire the goodneſs and wiſdom of God. If the rays did not divide, and were not differently coloured, every thing would be alike, and we could only diſtinguiſh objects by reaſoning, and by circumſtances of time and place.

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LESSON XXVII.

DIFFERENCE OF ZONES.

IN certain countries there is but one ſeaſon; the ſummer is continual there, and every day is as hot as our hotteſt ſummer days. Thoſe countries are ſituated in the middle of the globe, and occupy the ſpace called the Torrid Zone. The fineſt and richeſt fruits which nature produces grow there; and it is there in general where ſhe moſt liberally pours forth her treaſures. The days and nights are of equal length moſt of the year. There are, on the contrary, countries, where, during the greateſt part of the year, it is ſo extremely cold, as to be beyond our ſevereſt winters. It is but a few weeks in the year warm enough for the few trees and herbs which are there, to grow or become green; and in thoſe frigid zones, neither the trees nor the earth produce fruit which mankind could feed on. The greateſt inequality of day and night is there; each of them laſts in its turn for whole months together. The two temperate zones, placed between the torrid and the frozen, occupy the greater part of our globe. In thoſe countries, four ſeaſons appear more or leſs diſtinctly, according as they approach the torrid or the frigid zones:—the *ſpring*, wherein the trees and plants bud and bloſſom, the heat is moderate, and the days and nights nearly equal — the *ſummer*, during which the fruit of the field and trees ripen, when the heat is more intenſe, and the days become viſibly longer than the nights—the *autumn*, when the fruit and the ſeeds fall off, and the graſs withers, while the night again becomes equal with the day, and the heat is daily abating —the *winter*, during which the vegetation of plants totally or partly ceaſes, the nights lengthen, and the cold more or leſs increaſes. The countries of the temperate zones are ſo ſituated, that in thoſe which are near one of the ſides of the torrid zone, the ſeaſons are directly contrary to thoſe of the other temperate zone. When it is ſummer in one, it is winter in the other, &c. In theſe parts, nature ſhows more variety in the produce of the earth, and in animals, than elſewhere.

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LESSON XXVIII.

OBSERVATIONS ON THE DOG-DAYS.

THE Sun, beſides its diurnal motion, which appears to convey it from eaſt to weſt, and which occaſions the revolution of day and night, ſeems to have another motion from weſt to eaſt; by means of which, at the end of 365 days, it comes
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again near the ſame ſtars from which it had removed for ſix months, and to which it was drawing near the other ſix months. On this account aſtronomers have divided the ſeaſons according to the ſtars which the Sun meets in its annual courſe. They divided this courſe into twelve conſtellations, which are the twelve ſigns of the zodiac. The ſummer begins with us when the Sun enters the ſign Cancer, which happens the 21ſt or 22d of June. It is then that the Sun is raiſed at the higheſt above our horizon, and darts its rays almoſt directly upon us; and, of courſe, at that time begins the heat of ſummer, which always increaſes in the following month, by degrees, as our globe is more heated by the burning rays of the Sun. This is the reaſon that July and part of Auguſt is generally the hotteſt time of the year; and experience has proved, that from the 20th of July to the 10th of Auguſt the heat is at the height. Now, of all the ſtars in conjunction with the Sun, the *dog-ſtar* is the brighteſt. Loſt in the rays of the Sun, it diſappears from us for a month, as is the caſe with every ſtar which the Sun meets in its courſe; and the month of its diſappearing is the time of the *dog-days.*

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LESSON XXIX.

CAUSES OF THE HEAT OF THE EARTH.

WHEN the Sun is in the ſouth, the days are not ſo hot towards the north, as when that planet is near the Northern Pole. The ſame is obſerved in the ſouthern parts of the earth, when the Sun is turned towards the north. In countries where the Sun is generally vertical, the cold is never ſo great as to freeze the rivers or lakes; on the contrary, the heat is always intenſe: it becomes violent when the Sun is long above the horizon, and by that mean darts its rays for a time on the ſame place. This is the reaſon that towards the poles, where the days are not very long, the heat is ſometimes intenſe in certain countries. When all this is conſidered, we muſt neceſſarily conclude, that the Sun, and its poſitions with regard to the earth, is one of the chief cauſes of the heat in the open air. But this is not the only cauſe, for, if it were, all the ſummers would be equally cool; the temperature of the air muſt alſo be then exactly the ſame in all countries ſituated in the ſame climate; which is not the caſe. It is obſerved, that on the higheſt mountains, where there are ſpacious plains at top, and upon which there are alſo other hills and other plains, it is ſtill much colder than in low lands and deep vallies. It is certain there may be a heat in the air which is not immediately produced by the Sun. There are ſome bodies which by friction grow warm and take fire. The axle-trees of wheels take fire when the carriages go too faſt, and are not properly greaſed. Other ſubſtances grow warm, and even inflame, when they meet together If a certain quantity of water is poured on a bundle of hay or ſtraw, it will occaſion a conſiderable degree of heat. Thus, then, we may account for the production of heat in the open air. In the firſt place, the Sun is the principal cauſe of it: to the heat proceeding from this planet is united that of many living creatures; that of fire produced by wood, coal, and other combuſtibles; that which comes out of the bowels of the earth, the bottom of the ſea, and from mineral and warm ſprings. The heat is often much increaſed by the fermentations which different bodies undergo, whether on the ſurface of the earth, or in the higher atmoſphere, and which occaſion hot vapours. When, therefore, all ſorts of little particles, ſuch as float in the lower atmoſphere, and are calculated to receive and retain heat, grow warm, and are carried away by the wind or rain, the heat gradually increaſes, and becomes more and more intenſe. On the contrary, it abates when any of the abovementioned cauſes ceaſe.

All theſe plans are worthy of the wiſdom and goodneſs of God; they are uſeful to all the habitable parts of the globe; and he has granted to each climate that degree of happineſs it was ſuſceptible of. But WE, in particular, who live under a temperate climate, more ſenſibly experience his paternal care. Heat and cold are diſpenſed to us in the wiſeſt proportion; and we ſhould be the moſt ungrateful of beings, were we not to acknowledge and praiſe his goodneſs towards us.

For us kind Nature wakes her genial pow'r,
Suckles each herb, and ſpreads out ev'ry flow'r.
Annual for us the grape, the roſe renew,
The juice nectarious, and the balmy dew.
For us the mine a thouſand treaſures brings,
For us health guſhes from a thouſand ſprings,
Seas roll to waft us, *Suns* to light us riſe;
Our footſtool Earth—our canopy the ſkies.

LESSON XXX.

COLD AND HEAT.

COLD is only a comparative term, and ſignifies nothing more than a leſs degree of heat, which we uſually call a moderate warmth. It is well known, that many bodies will liquefy with one degree of heat, and become fixed with another; this is the caſe of all *metals*, *ſalts*, *oils*, *water*, &c. With one degree of warmth water will appear in a fluid ſtate; with a leſs degree the particles will be found to be fixed, congealed, or frozen. Thus the vapours in a warm air are in a fluid ſtate, and when condenſed by the cold of the evening, and deſcend, adhere to the blades of graſs, in the liquid forms of pearly drops, which are called *Dew:* theſe very particles in a colder air will be fixed, and while they are floating in the ſame they make what is called a *Frozen Miſt*.

HEAT.

All Heat conſiſts in the great velocity or ſwift motion of the parts of *matter*, and the velocity of the particles of light is the greateſt of any which are known in nature; we likewiſe find that thoſe particles, by their action, always produce the ſenſation of warmth or heat, and being plentifully imbibed by all kinds of bodies, theſe active particles are conſtantly employed to ſeparate the parts of bodies, and by theſe means produce the natural exhalations, or *ſteams* from every heated liquor: theſe ſenſible vapours riſe into the air, and make a part of the atmoſphere, for the air is conſtantly filled with particles of moiſture, which by heat are ſo far attenuated as ſeldom to be perceptible to the ſight; *wood* and *coal* are every day, in this manner, converted into air, without probably one reflection of ours on the nature of the thing, or being otherwiſe affected than by its *heat.*

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LESSON XXXI.

THE CLOUDS,

Thoſe beauteous robes of heaven, THOMSON.

ARE formed by the heat of the Sun, which draws the damps from the Earth, and the water from the rivers and ſeas, in the ſame manner as the fire draws the moiſture from a piece of wet paper or linen, if held near it; and this is called *evaporation.* When theſe vapours meet together in the air, they form clouds, which, when they become heavier than the air, break through it, and fall in *rain*; which is ſeparated into ſmall drops by the reſiſtance which it meets with from the air in falling.

LESSON XXXII.

HAIL.

HAIL aſſumes various ſhapes, being ſometimes round and at other times thin and flat, &c.

It is very difficult to account for it in a ſatisfactory manner, and there are various opinions upon this head. It is uſually conceived that hail is formed of drops of rain frozen in their paſſage through the middle region; others take it for the fragments of a frozen cloud half melted, and thus precipitated and congealed again. Beccaria ſuppoſes that it is formed in the higher regions of the air, where the cold is intenſe, and where the electric matter is very copious. In theſe circumſtances a great number of particles of water are brought near together, where they are frozen, and in their deſcent they collect other particles, ſo that the denſity of the ſubſtance of the hailſtone grows leſs and leſs from the centre, this being formed firſt in the higher regions, and the ſurface being collected in the lower.

Accordingly, in mountains, hailſtones, as well as drops of rain, are very ſmall, and both agree in this circumſtance, that the more intenſe is the electricity that forms them, the larger they are.

It is frequently obſerved, that hail attends thunder and lightning; and hence Beccaria obſerves, that as motion promotes freezing, ſo the rapid motion of the electrified clouds may promote that effect in the air.

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LESSON XXXIII.

RAIN.

WHEN the air is ſo full of heavy vapours that it can no longer ſuſtain them, then theſe ſmall moiſt particles adhering together fall down in fine drops which we call *rain*, which heat, cold, and wind,
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contribute to produce; and the rain falling in drops is a farther manifeſtation of Divine wiſdom, for, if it fell in ſtrong ſtreams, it would injure the earth by waſhing away its fine light mould from the roots and ſeeds, and we ſhould ſuffer great inconvenience from it.

The general cauſe of rain is an alteration of the weight of air, by which means the clouds deſcend, intermix, and embody together, and thereby become much heavier; the weight now forcing the aqueous particles together, they attract each other, in conſequence of which the clouds become liquefied, or diſſolved into water, much after the manner you ſee a heated ſteam or vapours become condenſed, or run into drops againſt any cold ſurface.

In the trueſt ſenſe of the word, rain ought to be called a preſent from Heaven. The bleſſings our Heavenly Father pours upon us by theſe means, are equally abundant and neceſſary for us. As the conſequences of a continued drought would be fatal ſatal to us, ſo the advantages are equally precious which the refreſhing ſhowers afford. Who can deſcribe or know all the benefits which accrue from them? But if we cannot give an exact account of them, we may at leaſt reflect on ſome of the moſt conſiderable. The heat of the Sun acts without interruption on the different bodies on the earth, and continually exhales thin particles from it, which fill the atmoſphere in the form of vapours. We ſhould breathe theſe dangerous exhalations with the air, if now and then they were not carried off by the rain, which beats them down to the ground, and thus clears and purifies the air. It is no leſs uſeful in moderating the burning heat of the atmoſphere; and the reaſon is very evident: for the nearer the air is to the earth, the more it is warmed by the refraction of the rays; and the farther it is from us, the colder it is.—The rain that falls from a higher region brings to the lower atmoſphere a refreſhing coolneſs, of which we always feel the agreeable effects when it has rained.

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LESSON XXXIV.

SNOW

IS occaſioned by the vapours becoming conſiderably condenſed, yet not ſo far as to be converted into water; when, by a great degree of coldneſs in the upper region of the air, the particles of the condenſed vapour form into ice, and adhering together compoſe ſnow, which conſiſts of ſmall fleeces of a white ſubſtance, ſomewhat heavier than the air, and which therefore fall down in a ſlow and gentle manner through it; being ſubject, by reaſon of their lightneſs, to be driven about by the various motion of the winds.

A frozen piece of water becomes ice. Snow differs from this only in the water of the ice freezing when it is of its uſual thickneſs, and the water of the ſnow, when its particles are ſtill ſeparate, or reduced to vapour. Experiments have been made, which prove that ſnow is twenty-four times lighter than water; and, that it fills up ten or twelve times more ſpace, at the moment of falling, than the water produced from it when melted; which could not be the caſe, if the ſnow was not a water extremely rarefied. But ſnow is not mere water, for the conſtruction of its particles, and the effects it produces, are different from that of water and ice. In this reſpect, the manner in which the ſnow forms itſelf has ſomething very remarkable in it.

When particles of vapour collected together freeze in the atmoſphere, the ſalt-petre diſperſed in the air comes and unites with it in the form of a little dart of a hexagon ſhape. While a great number of ſuch little darts unite together, the particles of water which are amongſt them grow hard, and take the form of the ſaltpetre. This accounts for the flakes with ſix ſides, which are compoſed of points like little needles, at each ſide of which, darts, or ſmaller threads, join themſelves, though their form frequently alters when carried here and there by the wind. Is it not an aſtoniſhing ſpectacle, to ſee that Nature has formed even the flakes of ſnow with the moſt exact ſymmetry? to ſee ſuch a prodigious number of them fall from the ſky? to obſerve the ſeveral forms water can take, under the creating hand of God?

A lady having arrived from *Jamaica*, a country where ſnow and ice have been heard of, but never ſeen, when ſhe firſt ſaw this new wonder of deſcending ſnow, ſtood in ſilent amazement for minutes, nor could ſhe be prevailed upon to turn her eyes from this unuſual ſight for a conſiderable time. *We* may ſee by theſe inſtances, how little mankind are affected by the wonderful operations of nature, when they become a common ſubject of our ſenſes.

" The eye marvelleth at the beauty of
" the whiteneſs thereof."

LESSON XXXV.

FROST.

ICE is a brittle, tranſparent body, formed of ſome fluid frozen or fixed by cold. The ſpecific gravity of ice to water is various, according to the nature and circumſtances of the water, degrees of cold, &c. Dr. Irving *(Phipps's Voyage towards the North Pole)* found the denſeſt ice he could meet with about a fourteenth part lighter than water. M. de Mairan found it, at different trials, one fourteenth, eighteenth, or nineteenth lighter than water; and when the water was previouſly purged of air, only a twenty-ſecond.

The rarefaction of ice has been ſuppoſed owing to the air bubbles produced in ice while freezing; theſe being conſiderably larger in proportion to the water frozen render the ice ſo much lighter. It is well known, that a conſiderable quantity of air is lodged in the interſtices of water, though it has there little or no elaſtic property, on account of the diſunion of its particles; but upon theſe particles coming cloſer together, and uniting as the water freezes, light, expanſive, and elaſtic air bubbles are thus generated, and increaſe in bulk as the cold grows ſtronger, and by their elaſtic force burſts to pieces any veſſel in which the water is cloſely contained.

THE FROST SOMETIMES SEEN ON GLASS WINDOWS.

This little phenomenon alſo ſhows us what variety, order, and ſimplicity there is in the ſmalleſt production of nature. We often admire the extraordinary figures which froſt upon the glaſs preſents to us; but it ſeldom happens that this object is attended to as much as it merits, however unimportant it may be in itſelf. The phenomenon in queſtion has its principle in the fluidity of fire. When it is confined in the warm air of a room, it tries to ſpread itſelf on all ſides, and to penetrate that part where there is leaſt matter homogeneal to its own. This is the reaſon it runs through the cloſe texture of glaſs, which contains neither air nor heat. In going through glaſs, it leaves at the inſide, and near any openings, the particles of air and water to which it was united. It forms itſelf into a cloud, which thickens in proportion as the fire goes out of it, till there remains too little of it in the room to preſerve the fluidity of the thickened particles of water on the glaſs. They then congeal, and the ſaltpetre in the air mixing with them, produces the variety of figures with which the glaſs is covered.

The beginning, or the ſketches of theſe figures, is formed by very ſmall threads of ice, which inſenſibly unite, till the whole glaſs is covered with a coat of ice. Theſe threads are the origin of all the figures; and the firſt weaving of theſe may be diſtinctly ſeen. We ſee at firſt ſome lines extremely fine, out of which lines come (nearly in the ſame manner as we ſee come out of a quill) ſome threads, which in their turn bear other branches. When it freezes hard, and the firſt coat of ice grows thick, it produces the moſt beautiful flowers and lines of every ſort, ſometimes ſtraight, ſometimes ſpiral. There is reaſon to believe, that this great variety of figures does not proceed entirely from the motion of the air; and the particles of fire, but in ſome meaſure from the little imperceptible chinks there are in glaſs. Whatever is the cauſe of the phenomenon, it is certain that this ſport of nature ſhows us much art, united with much ſimplicity.

Let us not diſdain to read on frozen glaſs, a truth which may have great influence upon our happineſs. Behold the flowers that the froſt has drawn upon that glaſs! They are varied with art and prettineſs; yet a ray of the noon-day ſun effaces them. It is thus that fancy often paints every thing to us in the faireſt light; but all that it repreſents to us moſt ſeducing, in the poſſeſſion of worldly goods, are merely fine images which diſappear by the light of reaſon. The importance of this wiſe leſſon is well worth the trouble of attending to the little phenomenon which produced it.

LESSON XXXVI.

DEW

Is a heavy moiſt vapour, falling on the Earth in form of a drizzling rain, whilſt the Sun is below the horizon. In ſummer, when the weather is fair and very dry, and the fields have been for a conſiderable time parched by the heat of the Sun, then the watery and other leſs volatile particles, as the oily, and the ſaline, or ſalt, are, by the power of the Sun's beams, raiſed above the ſurface of the Earth. As long as theſe exhalations are kept in agitation by the heat of the Sun, they are inviſible; but as ſoon as the heat of the Sun (which acts with the greateſt force about three in the afternoon) begins to remit, there is left a white denſe vapour, which remains on the graſs till it is diſſipated in the morning by the heat of the riſing Sun.

LESSON XXXVII.

A FOG

Is a meteor compoſed of groſs vapours floating near the Earth's ſurface. When the air is exceſſively cold, the vapours cannot aſcend through it, but are condenſed near the ſurface of the Earth; and either fall again in dews or drizzling rain, or remain ſuſpended as fogs; which are only clouds formed in the loweſt region of the air.

The condenſation of this vapour is either owing to a greater degree of warmth in the ſurface of the earth or water, which throws it off in greater proportion than common, and faſter than it can riſe through the atmoſphere: or elſe to a want of a greater degree of heat in the atmoſphere to attenuate thoſe vapours, and increaſe their elaſticity, and conſequently their rarity; for want of theſe qualities they are detained in the lower part of the atmoſphere in large and opaque particles, viſible themſelves to the eye, but preventing viſion of other objects through them.

VAPOURS

Are either thin, inviſible, moiſt particles, which float in the air, or being more condenſed, and by that means rendered viſible, are called clouds. This work of the Creator was obſerved of old: "He bindeth up the "waters in his thick clouds, and the "cloud is not rent under them."

Hence in the Lord of nature's great deſign,
Not Winter's ruſhing ſweep, nor the wild wing
Of whirlwinds howling o'er the boiling waves,
Nor the ſtrong ſtorm's loud uproar, leſs promote
The general end, than Summer's genial ray
That gilds the laughing landſkip; or the breeze
Of mellow Autumn, when the ripen'd ſheaf,
Nodding and copious, claims the reaper's hand.
OGILVIE.

LESSON XXXVIII.

WATER.

WHEN we drink water, we think we enjoy a pure and ſimple element: we are miſtaken; for the naturaliſts aſſure us, that each drop of water is a little world, where the four elements and the three kingdoms of nature unite. There is ſcarce any water which is not full of heterogeneous matter, very plainly viſible when diſtilled or filtered: however incredible this may appear, it has been proved, beyond all doubt, by the moſt exact and certain experiments. Beſides its elementary parts, the water contains ſeveral earthy particles: ſuch, for example, as belong to the mineral kingdom, chalky earth, ſaltpetre, and different kinds of ſalts. It cannot be doubted, if we conſider how many earthy particles the water muſt meet every where (both in the air and on the ground), parts that it diſſolves, or draws off and carries along with it. Water alſo contains inflammable or ſulphureous parts, which ſhow themſelves when it corrupts. Without theſe fiery particles, it would become a ſolid and compact body; for as ſoon as all its heat is taken from it, it condenſes, becomes heavy, and acquires the hardneſs of ice. Laſtly, that water is alſo impregnated with air will be eaſily acknowledged, if attention is paid to what happens when it begins to boil. Common water contains particles of earth, ſalts, fiery particles, and air; conſequently it may be ſaid, with truth, that all the elements meet in a drop of water. As to the animal kingdom, it is evidently diſtinguiſhed in water. Without mentioning fiſh, and other aquatic animals, with which it is peopled, there is not a ſingle drop of water without its inhabitants, as may be diſcovered by a microſcope.

LESSON XXXIX.

OF THE RAINBOW.

Look upon the Rainbow, and praiſe Him that made it: very beautiful it is in the brightneſs thereof; it compaſſeth the heaven about with a glorious circle, and the hands of the Moſt High have bended it.

Thus oft the Lord of nature in the air
Hangs evening clouds, his ſable canvaſs, where
His pencil dipp'd in heavenly colours, made
Of intercepted ſun-beams, mix'd with ſhade
Of temper'd ether and refracted light,
Paints his fair Rainbow charming to the ſight.
BLACKMORE.

THE Rainbow is a meteor in the form of a party-coloured ſemicircle, often ſeen in a rainy ſky oppoſite to the Sun, occaſioned by the refraction of his rays in drops of falling rain.

Refraction is the bending of the rays of light iſſuing from a heavenly body out of their direct lines.

Sir Iſaac Newton was the firſt who, in obſerving the effects of the priſm, found that a beam of light was variouſly refracted through it.

A priſm, in natural philoſophy, is a ſolid glaſs in the ſhape of the geometrical triangular priſm, through which the Sun's rays being tranſmitted are refracted into all the colours of the Rainbow; from which it is deduced, that the rays of the ſun's light are the natural cauſe of colours.

The Rainbow is formed by the rays of the Sun being refracted by the drops of falling rain, and thence reflected to the ſpectator's eye. Its colours are violet, indigo, blue, green, yellow, orange, and red.

The doctrine of the Rainbow may be illuſtrated and confirmed by experiment in ſeveral different ways: thus, by hanging up a glaſs globe full of water in the ſunſhine, and viewing it in ſuch a poſture that the rays which come from the globe to the eye may include an angle either of 42° or 50° with the Sun's rays; for example, if the angle be about 42°, the ſpectator will ſee a full red colour in that ſide of the globe oppoſite to the Sun. And by varying the poſition ſo as to make that angle gradually leſs, the other colours, yellow, green, and blue, will appear ſucceſſively in the ſame ſide of the globe, and that very bright. But if the angle be made about 50°, ſuppoſe by raiſing the globe, there will appear a red colour in that ſide of the globe towards the Sun, though ſomewhat faint; and if the angle be made greater, as by raiſing the globe ſtill higher, this red will change ſucceſſively to the other colours, yellow, green, and blue. And the ſame changes are obſerved by raiſing or depreſſing the eye while the globe is at reſt.

The philoſophers Plutarch and Pliny viewed the Rainbow as an object of wonder and admiration, but which they were unable to explain.

It is impoſſible that any reflecting mind can look on nature, and her various operations, without being filled with a ſpirit of adoration and praiſe: in the Rainbow we behold the Deity appeaſed, and in the ſilent lapſe of time, for many thouſand years, all ages have been a witneſs of the ſtrong compact of Heaven with man, when the world, by the height of its wickedneſs, was deſtroyed, and the Almighty declared, " I will eſtabliſh my covenant with you, neither ſhall all fleſh be cut off any more by the waters of a flood." " I do ſet my *bow* in the *cloud*, and it ſhall be the token of a covenant between me and the earth."

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LESSON XL.

THE SKY.

TO judge ſimply by our ſenſes, we might imagine the ſky over our heads a great vault painted blue. If we were raiſed very high above the ſurface of the earth, we ſhould find that the air becomes more and more ſubtile the higher we go, till we could no longer breathe in it, and at laſt it would end in pure ether. The higher we climb on mountains the more light the atmoſphere grows, and the more pale the bright azure of the ſky appears. If we could riſe as high as pure ether, this colour would be entirely loſt: the ſky would ſeem to us as black as at night; for all objects that do not tranſmit to us any rays of light appear ſo; conſequently, if the air that ſurrounds us was as tranſparent as ether, the ſky would not appear blue to us. Our air is full of little particles, which, when lighted by the Sun, receive a motion which produces new rays; and theſe particles, though dark in themſelves, become viſible to us when lighted up. Their colour is blue. However pale and ſlight the blue rays of air may be, there falls ſo great a quantity of them on our eyes, when we are in the open air, that the effect reſulting from them is rather a dark blue. Theſe reflections may make ſome conſider the ſky differently from what they had done before. It may from hence be concluded, that, to the very colour of the ſky, there is no phenomenon in nature in which we may not diſcover order, utility, and a wiſe purpoſe. The apartments of kings, decorated by the moſt ſkilful painters, are nothing when compared to the majeſtic ſimplicity of the celeſtial vault. When the eye has any time contemplated the beauties of the earth, it ſatiates and is tired; but the more we contemplate the heavens, the more charms we find in it.

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LESSON XLI.

MATTER.

BY the word matter is here meant every thing that has length, breadth, and thickneſs, and reſiſts the touch.

That matter can never put itſelf in mo-
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tion is allowed by all men, for they ſee that a ſtone lying on the plane ſurface of the earth never removes itſelf from that place, nor does any one imagine it ever can.

A bowl moves but a ſhort way upon a bowling-green, becauſe the roughneſs and unevenneſs of the graſſy ſurface ſoon creates friction enough to ſtop it; but if the green were perfectly level, and covered with poliſhed glaſs, and the bowl were perfectly hard, round, and ſmooth, it would go on a great way farther, as it would have nothing but the air to reſiſt it; if then the air were taken away, the bowl would go on without any friction, and conſequently without any diminution of the velocity it had at ſetting out; and therefore if the green were extended quite round the earth, the bowl would go on round and round the earth for ever.

We have many ſurpriſing inſtances of the ſmallneſs to which matter can be divided by art.

If a pound of ſilver be melted with a ſingle grain of gold, the gold will be equally diffuſed through the whole ſilver; ſo that taking one grain from any part of the maſs (in which there can be no more than the 5760th part of a grain of gold), and diſſolving in aqua fortis, the gold will fall to the bottom.

It is by *attraction* and *repulſion* that matter is put in motion; and that whenever by this means they could be ſeparated beyond the ſphere of attraction they command a repelling ſtate, and then, as they were at a greater diſtance from each other than before, they muſt become very light, and ariſe into the body of air in forms of vapours and exhalations of various kinds. Thoſe elaſtic particles that riſe viſible to the ſight are what are uſually called *Vapours* or *Steam*; ſuch as we ſee riſe from the ſurface of heated water, and other moiſt ſubſtances.

LESSON XLII.

PHILOSOPHICAL REMARKS.

PHILOSOPHY is natural logic; by it we are convinced, that the reſpective weights of bodies do not depend on their viſibility; the *fiſh*, in the element of water, ſee no more the parts of water than we do of air; but the buoy, and other objects floating on the ſurface, are the objects of their ſight, in the ſame manner as vapours and clouds are of ours.

There is no difficulty in finding a lighter body will ever aſcend or riſe in a heavier one; a piece of cork, for inſtance, placed at the bottom of a veſſel of water, and there left to itſelf, will riſe to the top immediately, by reaſon of the ſuperior weight and denſity of the water.

It is a miſtake when perſons ſuppoſe that the velocity of falling bodies is proportioned to their weights, for the velocity is proportioned to the force of gravity on a ſingle particle of matter in any body, and this force being equal on all particles, produces an equal velocity in deſcent upon them all, whether it be a feather or a guinea; for each particle being impelled with the ſame force, it therefore follows, one ſingle particle will deſcend juſt as faſt as a greater number; or, in other words, a light body will fall juſt as faſt as a heavy one in an *unreſiſting medium.*

LESSON XLIII.

HOURS.

THE diviſion of the day into hours is very ancient, as is ſhown by Kircher. The moſt ancient hour is that of the twelfth part of the day. Herodotus, who lived 413 years before Chriſt, informs us, that the Greeks learnt from the Egyptians, among other things, the method of dividing the day into twelve parts.

The diviſion of the day into twelve hours was not known to the Romans before the Punic war: till that time, they only regulated their days by the riſing and ſetting of the Sun: they divided the twelve hours of their day into four parts, and the night into four watches, each containing three hours.

Equal hours are twenty-four parts of a day and night preciſely, that is, the time in which the fifteen degrees of the equator paſs the meridian.

* * *

LESSON XLIV.

NIGHT.

As the night is, in itſelf, one of the Creator's favours, ſo is it a wiſe and beneficent diſpenſation that it only comes on by degrees. A ſudden tranſition from the light of day to the darkneſs of night would be both inconvenient and frightful. So ſudden a change would occaſion a general interruption to the labours of man, which, in certain affairs neceſſary to be finiſhed, and which do not admit of delay, would be very prejudicial. All nature, men and animals, would be ſeized with fright; and, in this ſudden tranſition from light to darkneſs, it would be impoſſible that the organs of ſight ſhould not ſuffer very much. — Darkneſs, therefore, does not come upon us of a ſudden; it advances ſlowly; and the twilight, preceding night, leaves us time to finiſh our moſt preſſing buſineſs, and to make the neceſſary arrangements. By this means, the coming of the night does not diſturb or incommode us, and we are warned in time to prepare for it. But from whence proceed theſe remains of light, which, at the end of each day, in ſome degree, temper and ſoften the melancholy appearance of night? We no longer ſee the Sun, and yet a part of its mild luſtre ſtill reflects itſelf. Let us, in this, admire the wiſe and beneficent plans of nature. The atmoſphere which ſurrounds us has been ſo formed as to do us this eſſential ſervice. The rays of the Sun which fall on the upper parts of the air do not run in a direct line, but they bend, and this bend leads them where their firſt direction would have carried them: the atmoſphere, having thus bent and turned back a great number of rays, which otherwiſe would not have reached us, reflects them afterwards to our ſight, and, by this means, we enjoy light much longer, and the time for labour is conſiderably prolonged.

It is thus that a gracious Providence has planned not only the great revolutions of ſeaſons, but alſo the daily tranſition from light to darkneſs, in the manner moſt advantageous to us.

LESSON XLV.

OBSERVATIONS ON THE ORDER OF NATURE.

ALL the viciſſitudes of nature are derived from the invariable laws eſtabliſhed by the Creator, when he drew the univerſe out of nothing. For five thouſand years, there has been ſeen in the ſky, and upon the earth, at certain marked periods, the return of the ſame variations and the ſame effects. The ſun, moon, and ſtars, continue conſtantly the ſame courſe once preſcribed to them. But who is it that ſupports, that directs them? Who teaches theſe bodies the courſe they ought to take? Who points out to them the time for their revolutions? Who empowers them to move always with the ſame force? Who prevents them from falling on our globe, or from loſing their way in the immenſe ſpace of the heavens? All theſe queſtions lead us to God. It is he who appointed the circles they were to deſcribe; it is he who ſupports, who guides, and prevents them from confuſion. By laws unknown to us, he cauſes thoſe celeſtial bodies to move with incredible ſwiftneſs, and with ſuch perfect regularity, that nothing can diſturb it. Nearer to us, there are, in the elements, continual revolutions, though they are not viſible to common obſervers. The air is in perpetual motion round our globe. The water continues its courſe, in the ſame manner, without ceaſing. The rivers run into the ſea; and, from its broad ſurface, vapours riſe, which produce clouds. Theſe fall again upon the earth, in rain, ſnow, and hail. They penetrate into the mountains, and fill the ſprings; from whence rivulets become rivers, when they have met, and are thereby augmented in their courſe. Thus, the water, which had fallen from the cloud, returns back into the ſea. The ſeaſons laſt a limited time, and ſucceed each other, according to the order once eſtabliſhed. Each year the fertile earth produces again its plants, and its harveſt. Yet it is never exhauſted; for, by means of the continual circulation in all the nutritive parts, whatever the earth yields is reſtored to it again. The winter comes at the appointed time, and brings the repoſe it has occaſion for; and, when it has fulfilled the deſigns of the Creator, the ſpring ſucceeds; and this reſtores to the earth the children it has loſt.

All theſe revolutions lead us to reflect on the Supreme Being, who laid the foundation of them at the creation of the world; and who, by his power and wiſdom, has continued to direct them to this very moment.

LESSON XLVI.

OF THE CONNEXION OF RELIGION WITH THE STUDY OF NATURE.

Nature is but a name for an effect
Whoſe cauſe is God. COWPER.

THE impreſſions we receive from the contemplation of the works of nature, muſt neceſſarily be connected with that beautiful chain of reaſoning which brings us to a knowledge of the Deity himſelf; nor can the human mind enjoy more intellectual pleaſure than from the aſſurance, that there is an Almighty and Benevolent Being who not only regulates the ſyſtem of worlds, but who extends his paternal care to the meaneſt of his creatures.

We are told that the very hairs of our head are numbered—then how much reaſon have we to glorify him? Let us praiſe him when the ſummer's Sun cheers us with its beams; let us adore him in the calm retreats of ſolitude, and fear him in the ſtorm.

Whether the bloſſom blows, the ſummer ray
Ruſſets the plain, inſpiring Autumn gleams,
Or Winter riſes in the blackening eaſt,
Still praiſe the God of Seaſons as they roll. THOM.

Devotion is naturally the reſult of thoſe exalted ideas, which meditate the divine perfections, and the wonders of nature; it is love and admiration, thankfulneſs and praiſe. "Bleſs the Lord, O my ſoul! O Lord my God, thou art very great! Thou art clothed with honour and majeſty!"—Such is the language of true piety, whoſe pleaſing leſſons beſtow contentment, ſoften adverſity, and cheer and gladden us through all the changes and troubles of life. She inſtructs in virtue, directs us to be charitable and humane, and to love one another. She pours the balſam into the wounds of diſappointment, and raiſes the deſponding heart; ſhe is ever mild and ſerene, and can afford us, what is moſt ſought for, *happineſs*. The lovelineſs of her countenance is ſuch, that care conſtantly flies her preſence ; her eyes have the power to ſoften revenge, hatred, and malice, and her ſmiles diſſipate the pangs of contrition and remorſe ; ſhe teaches with gentleneſs and truth, and has ſo much perſuaſion and ſweetneſs in her manner, that all who attend to her—are delighted and inſtructed.

Liſten then to her voice, ye much favoured children of Providence, and learn to know, that the only way to be *happy* is to be *good*.

LESSON XLVII.

OF THE PROVIDENCE OF GOD.

———When Wiſdom ſpeaks
To man, ſhe calls him thro' th' external form
Of Nature, thro' Religion's fuller noon,
Thro' life's bewildering mazes, to obſerve
A Providence in all. OGILVIE.

PROVIDENCE is the direction of the ſeveral parts of the univerſe by a ſuperior Being.

Providence, according to Boethius, a Roman philoſopher, is but another name for Divine Wiſdom itſelf, may we not ſay, with equal juſtice, for Divine Love, ſince that attribute of the Deity is viſible through all creation. We have only to contemplate the wonders of nature, to liſten to the ſweet voice of religion, and to obſerve, with attention, the changes and viciſſitudes of human life, to be convinced—that there is " a Providence in all."

That we may be the more ſenſible of the

goodneſs of the Deity, let us review the faithful hiſtory of the life of man:—In our infancy, Providence has directed, that a mother's tender care and ſolicitude ſhould nouriſh and protect her helpleſs child: nor is that care and ſolicitude confined to human beings only; the ſame Providence inſtructs the wren to build its neſt with admirable contrivance, and to feed and cheriſh her young till they are able to fly; ſhe then indeed leaves them. It is not ſo with man: a mother's anxious love is ſucceeded by a father's prudential care; he teaches, he inſtructs, he diſpoſes the heart to virtue; at laſt, when it is neceſſary for the young traveller to venture on the journey of life, he ſets out, to appearance as it were, alone; but that is far from being the caſe: the ſame Providence which directed a mother's care to nouriſh him when an infant, and a father's prudence to inſtruct him in riper years, is ſtill near to watch and direct his ſteps, and to diſpoſe of every thing for his future good: even the moſt trifling incidents have their purpoſe, he is awakened through them to charity, pity, gratitude, generoſity, and love. Sometimes it may appear, Providence acts in form of diſappointment, or turns him from folly by adverſity, but ſtill he does not leave the much-favoured pilgrim till he neglects his bleſſings, or offends by hardened and implacable vice. How pleaſing is ſuch an idea, that the Almighty directs our ways, and keeps us in the paths of ſafety, that he will aſſiſt us when we are oppreſſed with ſorrow, and will come to our aid in the moment of diſtreſs!

The Providence of God is in nothing more viſible than in the beautiful hiſtory of Joſeph; we may there obſerve the hand of Heaven, and the ſecret chain that led to all his honours and preferments—"Becauſe the Lord was with him, and that which he did the Lord made it to proſper."—How delightful is ſuch a dependence, and how tranquil and happy muſt the mind of that man be, who looks up to the great Lord of the Heavens and the Earth as *his friend*; who knows that his Providence directs all things, and who, in the moſt trying ſituations of life, places his truſt in *God*.

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